AD NUMBER

AD893683

NEW LIMITATION CHANGE

TO

Approved for public release, distribution unlimited

FROM

Distribution authorized to U.S. Gov't. agencies only; Test and Evaluation; JAN 1972. Other requests shall be referred to Aeronautical Systems Division, Attn: SDQH, Wright-Patterson AFB, OH 45433.

AUTHORITY

ASD, USAF ltr, 17 Apr 1974

See 1473 at end

10

FTC-TR-71-37

AD893683

FTC-TR-71-37

FILE COPY

AD INEXPLORATA

ADDENDUM

UH-1N CATEGORY II AIRFRAME AND SUBSYSTEMS EVALUATION

AFFTC

ALFRED H. BOYD
Systems Project Engineer

TECHNICAL REPORT No. 71-37

MARCH 1972

Distribution limited to U.S. Government agencies only (Test and Evaluation), January 1972. Other requests for this document must be referred to ASD (SDQH), Wright-Patterson AFB, Ohio 45433.

AIR FORCE FLIGHT TEST CENTER
EDWARDS AIR FORCE BASE, CALIFORNIA
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE

ACCESSION for

CFSTI	WHITE SECTION	☐
DDC	BUFF SECTION	☐
UNANNOUNCED		☐
JUSTIFICATION		
BY		
DISTRIBUTION/AVAILABILITY CODES		
DIST.	AVAIL. and/or SPECIAL	
B		

Qualified requesters may obtain copies of this report from the Defense Documentation Center, Cameron Station, Alexandria, Va. Department of Defense contractors must be established for DDC services, or have "need to know" certified by cognizant military agency of their project or contract.

DDC . .ase to OTS is not authorized

When US Government drawings, specifications, or other data are used for any purpose other than a definitely related government procurement operation, the government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the government may have formulated, furnished, or in anyway supplied the said drawings, specifications, or any other data is not to be regarded by implication or otherwise, as in any manner licensing the holder or any other person or corporation or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

Do not return this copy, Retain or destroy

DEPARTMENT OF THE AIR FORCE

HEADQUARTERS AERONAUTICAL SYSTEMS DIVISION (AFSC)

WRIGHT-PATTERSON AIR FORCE BASE OHIO 45433

REPLY TO ATTN OF: ASD/SDQH 3-116 (Major Thompson/ech/54480/R&D 13-2-3/UH-1N)

SUBJECT: ASD Addendum Report to FTC-TR-71-37, UH-1N Airframe and Subsystems Evaluation

TO: Recipients of FTC-TR-71-37, Nov 71 and Mar 72

This report is a part of and should remain attached to FTC-TR-71-37, UH-1N Airframe and Subsystems Evaluation. The paragraph numbers below correspond to recommendations in the AFFTC Technical Report.

1. Concur with intent. Investigative and corrective actions which began with receipt of UMRs will be completed according to normal procedures.

2. Concur with intent. ASD will investigate this recommendation in light of LAU-59A replacement by the LAU-68A/A and will then incorporate the required information in the appropriate manuals.

3. Concur with intent, but not with recommended action. The lightweight, inherently simple design of the UH-1N skid system makes ground handling more difficult to some extent. The airframe contractor has investigated and proposed several unsatisfactory solutions to this problem. ASD plans no further action without a substantiated user requirement. The recommendation should be considered in future helicopter procurement, if applicable.

4. Do not concur. The present configuration is optimum to provide maximum protection to the pilot and copilot. Any substantial change would tend to degrade the protection provided. No adverse comments on this system have been received from any operator. The anticipated costs associated with this recommendation would not be commensurate with the benefit to be derived. ASD plans no further action without a user requirement. The "universal" armored seat (under development for the UH-1/H-3/H-53) should be considered for future procurements, if applicable.

5. Concur with intent. The UH-1N Survivability/Vulnerability (S/V) study considered additional armor plate protection for the redundant hydraulic tail rotor components in the transmission compartment. ASD is awaiting direction and funding for S/V changes.

6. Concur with intent. ASD has initiated action to incorporate the required information in the appropriate aircraft manuals.

7. Concur with intent. ASD has requested an Engineering Change Proposal (ECP 566R2) which, in part, provides the capability to illuminate the generator caution light any time the start switch is engaged.

8. Concur with intent. ASD has procured an ECP to provide positive closure lock of the rescue hoist hook using a "pip pin".

9. Concur with intent, but not with recommended action. ASD will change procedures to pre-position the non-essential bus switch to MANUAL before using the hoist. Modification is not warranted, so long as electrical power is assured.

10. Concur with intent. ASD is investigating the incorporation of a "cat-eye" cover over the light for dimming purposes.

11. Concur with intent. Published information provides for safe operational limits at the most stringent condition specified in the hoist procurement. ASD will attempt to obtain additional information to clarify limits for reduced loads and incorporate in the appropriate aircraft manuals.

12. Concur with intent. ASD has requested WRAMA publish criteria for a one-time inspection of all components in the suspect loudspeaker systems.

13. Concur with intent. ASD will request the responsible contract administration agency to institute improved quality control procedures and functional checks during acceptance tests for any future procurement of this system.

14. Do not concur. After extensive field use, the operator has expressed satisfaction with the loudspeaker kit. ASD plans no further action without a substantiated user requirement.

15. Concur with intent. See GENERAL COMMENT at the close of this Addendum Report. No additional program funds are available for such extensive changes (which exceed the scope of the UH-1N procurement program). The user must substantiate the requirement for preselected channel capability (as a formal ROC) for separate direction and funding.

16. Concur. ASD has further defined the operation of the VHF-FM homing function in the flight manual (change 1, dated 15 October 1971).

17. Concur with intent. Since the ID-387/ARN (AERNO 81-3386) is government furnished, ASD/SDQH will forward the recommendation to the appropriate procuring activity for consideration.

18. Concur. The modified UH-1D antenna kit was deficient as installed on the UH-1N. The standard UH-1N kit is designed to avoid contact with the cargo door. ASD plans no further action on this recommendation, unless the users report interference with the UH-1N kit.

19. This recommendation was complied with by the AFFTC Test Team after publication of the November 1971 basic report, and results were published in AFFTC Addendum to FTC-TR-71-37, March 1972. ASD concurs with the latter recommendation (which superseded original recommendation 19). ASD will initiate action to incorporate the required information in the appropriate aircraft manual.

20. Concur with intent. ASD/SDQH has forwarded this recommendation to the Life Support SPO for consideration.

21. Concur with intent. ASD has initiated action to incorporate the required information in the appropriate manuals.

22. Do not concur. As stated in ASD Addendum to FTC-TR-71-38, "Present location of the magnetic compass which was dictated by the aircraft magnetic field is optimum, considering the standby function of the instrument".

23 through 25. Do not concur. The discrepancies cited were not encountered during Category I Avionics Tests. Overall system performance is acceptable. Further testing is beyond the scope of the UH-1N procurement program without a substantial user requirement for greater accuracy. ASD plans no further action without direction and funding for user requirement, if any.

26 and 27. Concur with intent. ASD has initiated action to incorporate the required information in the appropriate aircraft manuals.

28. Do not concur. After discussion at the Cockpit Review, the present location was approved as optimum without major instrument panel reconfiguration.

29. Concur. ASD/SDQH has procured airframe ECP 580R1 to provide the required power.

30. Do not concur. Various alternate locations (for accessibility) discussed during the Cockpit Review and System Safety Review are not feasible.

31. Concur. ASD will request an ECP to correct this deficiency. An additional IFF antenna and SA-1474/A switching unit may be required.

32. Concur with intent. An active engine product improvement program (PIP) has resulted in several changes which contribute to propulsion system reliability. For the electrical system, two ECP actions are in progress; ECP 566R2 adds a 30VA inverter for improved battery start capability, and ECP 644 is designed to improve generator load sharing to avoid unwarranted off-line conditions. For communications equipment, ASD has approved ECP 616 to incorporate cooling in the center console which should improve component reliability. Other than these specific actions (and the engine PIP), ASD has no "continuous" effort to improve reliability of these miscellaneous subsystems. Reliability of weapons systems that are out of production is a logistic function. Operators must document sufficient failures to reach statistical "thresh-hold of significance" for reliability projects to be established by AFLC. Reliability considerations should be included in future helicopter procurements, if applicable.

33. Concur. Recommendation should be considered in any future helicopter procurement, if applicable.

34. Concur. ASD has requested corrective action by WRAMA via TCTO method.

35. Do not concur. No adverse comments or URs on this component have been received from any operator. If field experience justifies corrective action at a later date, then this recommendation should be considered in future helicopter procurement, if applicable.

36. Concur with intent. ASD will initiate action to amplify instructions in aircraft manuals in lieu of ECP action for placards.

37. Concur with intent. However, no adverse comments have been received from any operator. ASD plans no further action without user requirement.

38. Concur. Recommendation should be considered in any future helicopter procurement, if applicable.

39. Concur with intent. This will be covered in forthcoming NDI Manual. Additional corrective action may involve incorporating precautionary information in maintenance procedures.

40. Concur with intent. Due to lack of field input, retrofit by ECP for this minor change is not warranted. The costs associated with this change are not commensurate with the benefit to be derived.

41. Do not concur. Other external grounding receptacles are available. The forward grounding receptacle is located to facilitate avionics maintenance in the nose.

42. Do not concur. Anticipated costs for additional metal protection are not commensurate with system benefit. Recommendation should be considered in future procurements, if applicable.

43. Concur with intent, but not with recommended action. No adverse comments on this feature have been received from any operator. The procurement of additional AGE for this purpose is not justified. ASD plans no further action without a substantiated user requirement.

44 and 45. Concur with intent, but not with recommended action. No adverse comments have been received from using commands. The costs associated with such changes are not commensurate with anticipated benefit. ASD plans no further action without operational requirement.

46. Concur with intent, but not with entire recommendation. As stated in ASD Addendum to FTC-TR-71-36, "Pursuant to safety of operation such recommendations are incomplete without specific (minimum) number of handgrips with required dimensions and locations. Consideration will include flight safety, survivability, and degradation of presently available cargo area. Action is withheld pending receipt of user requirement. Recommendation should be considered in future procurement, if applicable".

47. Concur with intent. ASD will investigate incorporation of a dual filament bulb in the operator handgrip.

48. Concur with intent. ASD has initiated action to incorporate the required changes in the appropriate aircraft manual and to remove the misleading decal.

49. Concur. This quality control problem (observed early in production) has been corrected.

50. Concur with intent. This has been a continuing problem with labels in an oily environment. Labels should be replaced when deteriorated, and may be overcoated at the user's option.

51. Do not concur. No adverse comment on this feature has been received from any operator. The procurement of additional AGE for this purpose is not justified. ASD plans no further action without user requirement.

52. Do not concur. The rotor hub balancing kit is designed for use on a leveling table.

53. Do not concur. No adverse comments on this feature have been received from operational units. Procurement of additional AGE for this purpose is not justified without further field input.

54. Concur. This requirement is established in existing directives.

55. Concur with intent. ASD has initiated action to incorporate the required information in the appropriate aircraft manuals.

56. Concur with intent, but not with recommended action. Noise reduction modifications to the grenade launcher are not feasible within the original scope of the UH-1N acquisition program. This recommendation should be considered in future procurements, if applicable.

57 and 58. Concur with intent. ASD has initiated action to incorporate the required information in the appropriate manuals.

GENERAL COMMENT: Procurement of the UH-1N as an "off-the-shelf" helicopter was directed by USAF with a fixed schedule for rapid deployment to SEA. Incorporation of the new T-400 engine which required initial flight rating and extensive qualification tests, demanded a major airframe development effort during the acquisition of a "production" aircraft. In addition, the original major user (TAC) needed an integrated armament system for the Special Operations mission, which also required development and extensive qualification testing. To deploy on time (Nov 70), the program direction dictated

accelerated test and production schedules. (All operational aircraft were delivered within eight months, ending April 71). Despite maximum acceleration of testing, the directed combat deployment preceded completion of tests. As a result of program schedules (and with the exception of early safety-of-flight deficiencies which were corrected in production), fixes for test/operational discrepancies require costly retrofit changes by TCTO. The user has accumulated extensive operational experience with the existing system prior to completion of tests identifying discrepancies; consequently, ASD action on test recommendations considers current user requirements determined by operational experience. In some cases, the costs associated with desired changes may not be commensurate with the system benefit or with the priority of user's mission-oriented requirements. For information, the reallocation of aircraft to MAC has made ARRS the major user and has significantly reoriented mission requirements. Also, some test recommendations exceed the scope of the UH-1N program and should be considered in future procurements, if appropriate.

FOR THE COMMANDER

William D. Eastman Jr.

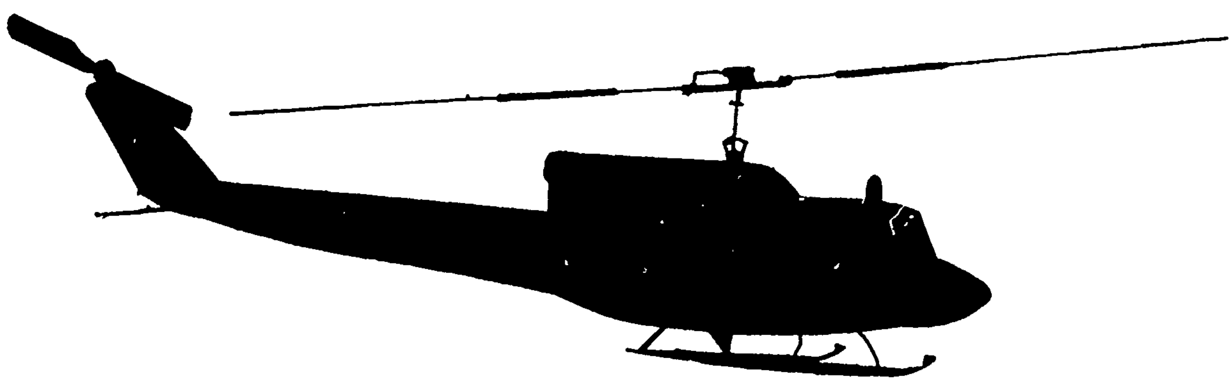
WILLIAM D. EASTMAN, JR., Lt Col, USAF
Chief, Helicopter Programs Division
Directorate of Combat Systems
Deputy for Systems

FTC-TR-71-37

ADDENDUM

UH-1N

CATEGORY II AIRFRAME AND SUBSYSTEMS EVALUATION



ALFRED H. BOYD
Systems Project Engineer

Distribution limited to U.S. Government agencies only (Test and Evaluation), January 1972. Other requests for this document must be referred to ASD (SDQH), Wright-Patterson AFB, Ohio 45433.

FOREWORD

The tests described in this addendum were conducted at the Air Force Flight Test Center to evaluate the radiation pattern of the long wire antenna used on the high frequency radio set of UH-1N aircraft. The tests were conducted subsequent to the UH-1N Category II airframe and subsystems evaluation (reference 1) because difficulties with the HF impedance matching network, CU-1658A, precluded completion of the test on UH-1N S/N 69-6610. A two-flight evaluation was conducted with UH-1N S/N 68-10774 to obtain the data presented in this addendum. This addendum completes the testing of the AN/ARC-102 high frequency radio set. The tests were authorized by AFFTC Project Directive 69-49B. Mr. John Somsel was the project officer, and the project pilot was Major Edward B. Russell.

Prepared by:

Alfred H Boyd

ALFRED H. BOYD
Systems Project Engineer

Reviewed and approved by:
18 FEBRUARY 1972

James W Wood

JAMES W. WOOD
Colonel, USAF
Commander, 6510th Test Wing

Robert M White

ROBERT M. WHITE
Brigadier General, USAF
Commander

INTRODUCTION

EQUIPMENT DESCRIPTION

The AN/ARC-102 high frequency (HF) receiver-transmitter set provided transmission and reception of single-side-band, AM and CW signals within the HF range of 2,000.0 to 29,999.9 kHz on any of 280,000 channels. The HF set provided long range, two-way communciation for air-to-air and air-to-ground communications. The set consisted of the following units: receiver-transmitter unit, RT 698/ARC-102, power inverter, PP-3702/ARC-102, HF control unit, C3940/ARC-94, HF impedance matching network, CU-1658A (antenna coupler), and antenna kit BHC P/N 212-706-004 (HF long wire) mounted along the tail boom of the helicopter. Primary power to operate the receiver-transmitter set was supplied from the aircraft 28 vdc essential bus.

TEST OBJECTIVE AND METHOD

The test objective was to determine antenna radiation patterns of the HF receiver-transmitter set at six frequencies spread throughout the spectrum covered by the AN/ARC-102 HF receiver-transmitter set.

The aircraft was flown in a circular pattern at 2,500 feet AGL, 12 NM west of the ground receiving station at a near hover airspeed over a ground reference point. Using this flight procedure, the aircraft could be quickly placed on any desired heading.

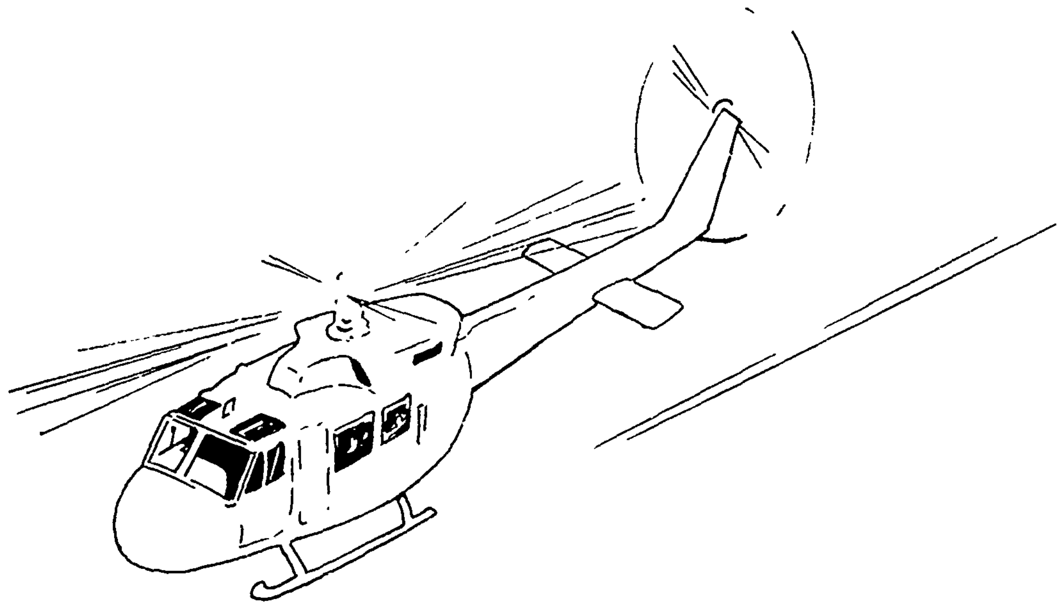
The antenna pattern was measured by transmitting a carrier in the AM mode when the aircraft was on each of 12 headings starting at 360 degrees and proceeding through 030, 060, 090, etc. The signal strength for each heading was recorded at the ground station and plotted.

TEST AND EVALUATION

FUNCTIONAL ANALYSIS

The signal strength recorded at the ground receiving station was a function of aircraft transmitter power, transmitter antenna directional characteristics, and the frequency selected. The transmitter power was assumed constant on any frequency; however, it varied when the test frequency changed. The efficiency of the transmitting antenna was a function of frequency and bearing of the ground receiving station from the aircraft. On any test, the frequency was constant and aircraft heading was the controlled test variable. The ground receiving station was not calibrated for field intensity and thus could give only relative signal strength information. For these reasons the maximum signal strength (microvolts) for each frequency was used as a zero db reference, and the patterns were plotted in db below this maximum level as shown in figures 1 through 6.

The antenna radiation patterns were essentially non-directional with pattern nulls of 2.67, 3.35 and 2.86 db, respectively, on frequencies 3,376, 3,890, and 7,110 kHz. More pronounced pattern nulls of 8.09, 9.40, and 7.75 db, respectively occurred on frequencies 14,100, 18,005 and 21,100 kHz. The bearing of antenna pattern nulls were different for each frequency tested. However, in all cases the signal strength improved at a bearing of 90 degrees from the pattern nulls.



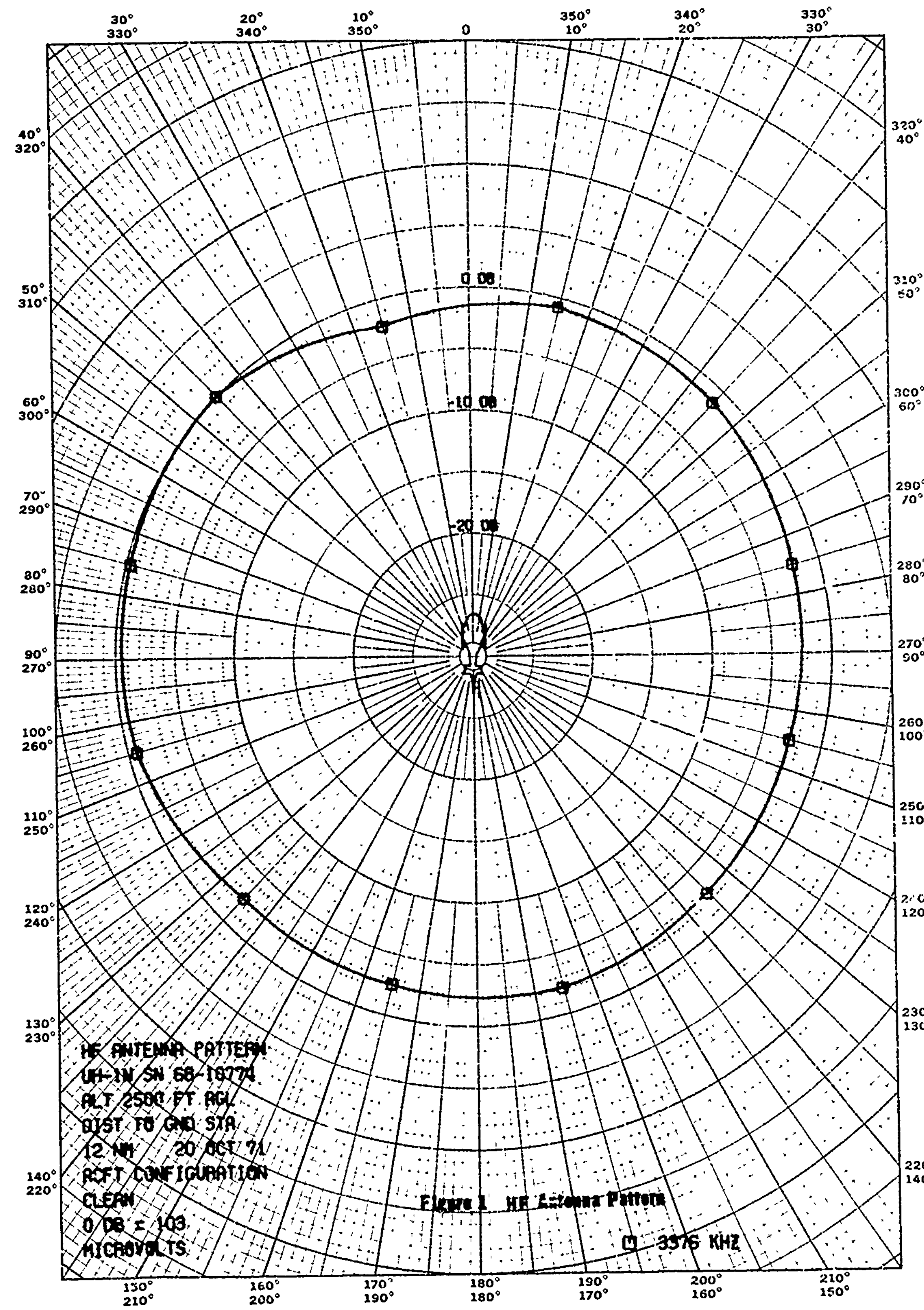


Figure 1 HF Antenna Pattern

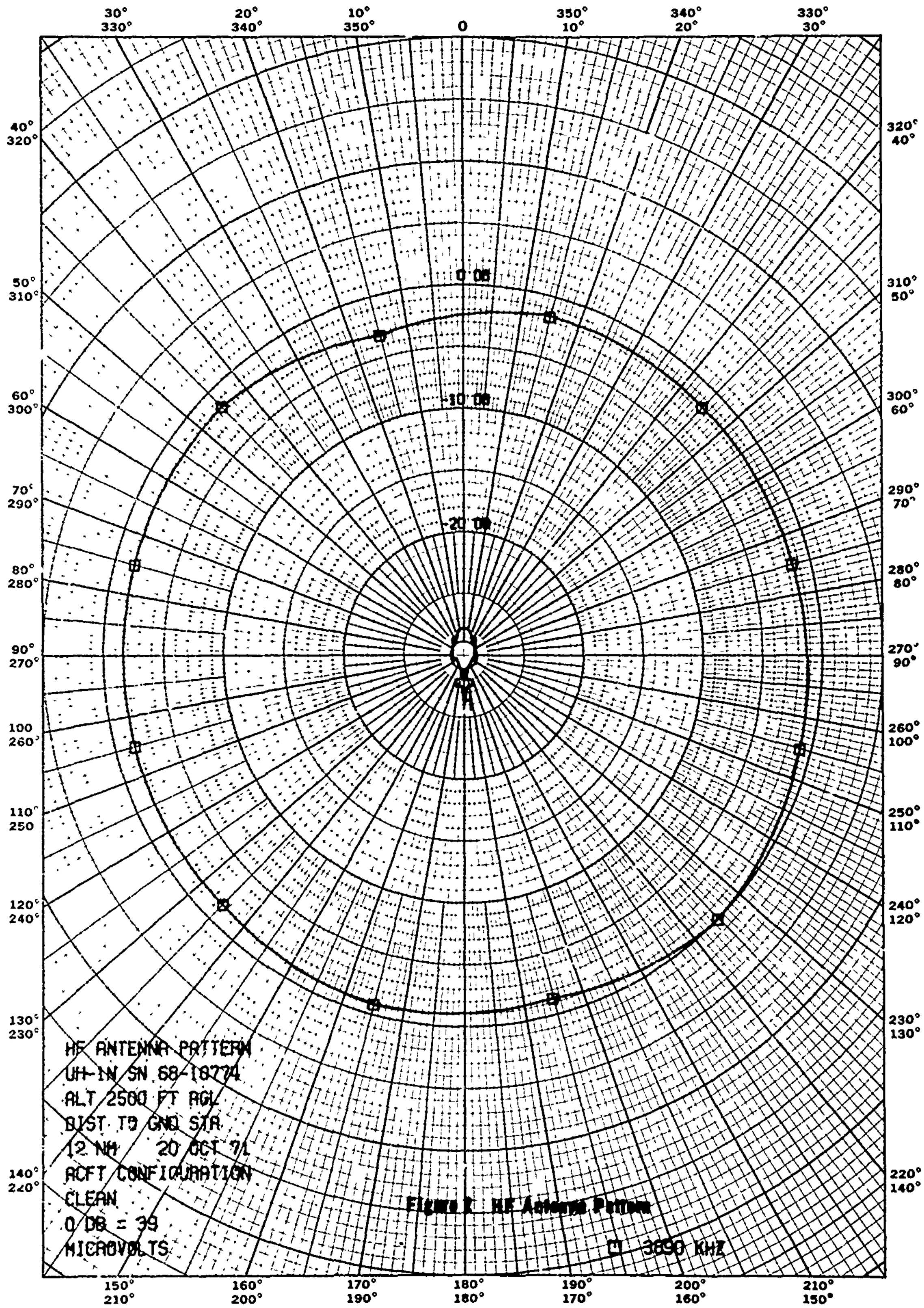


Figure 2 HF Antenna Pattern

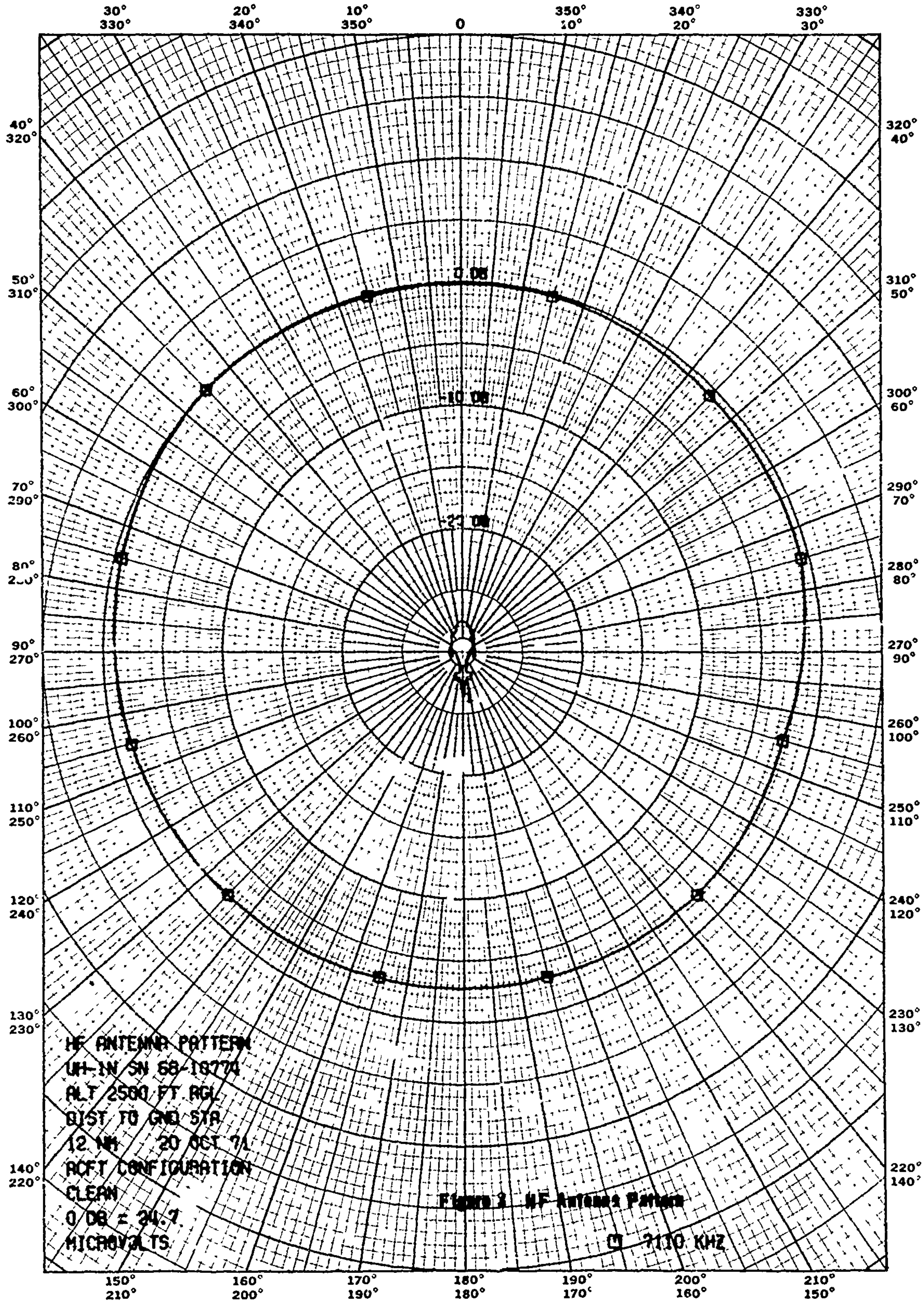


Figure 3 HF Antenna Pattern

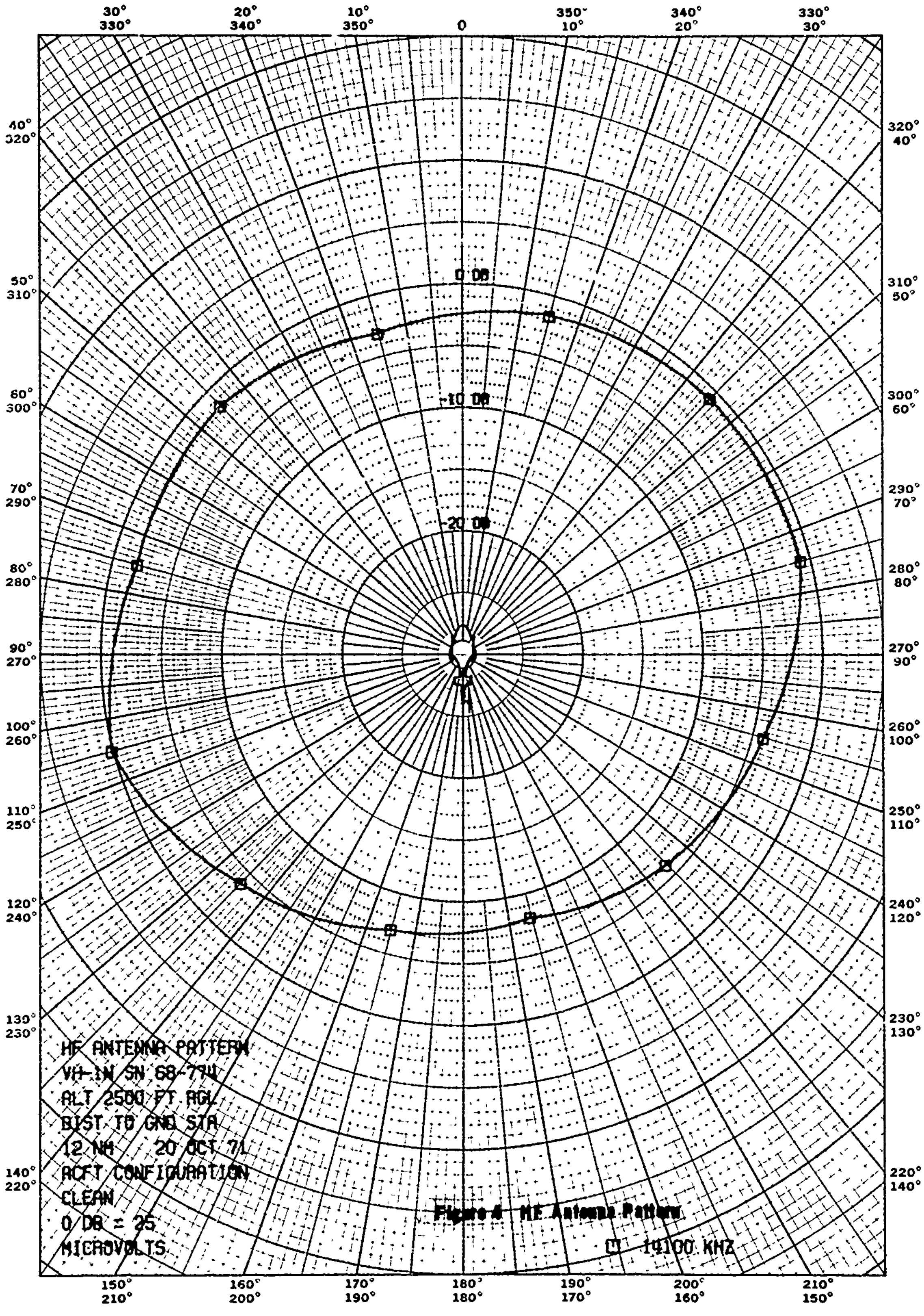


Figure 4 HF Antenna Pattern

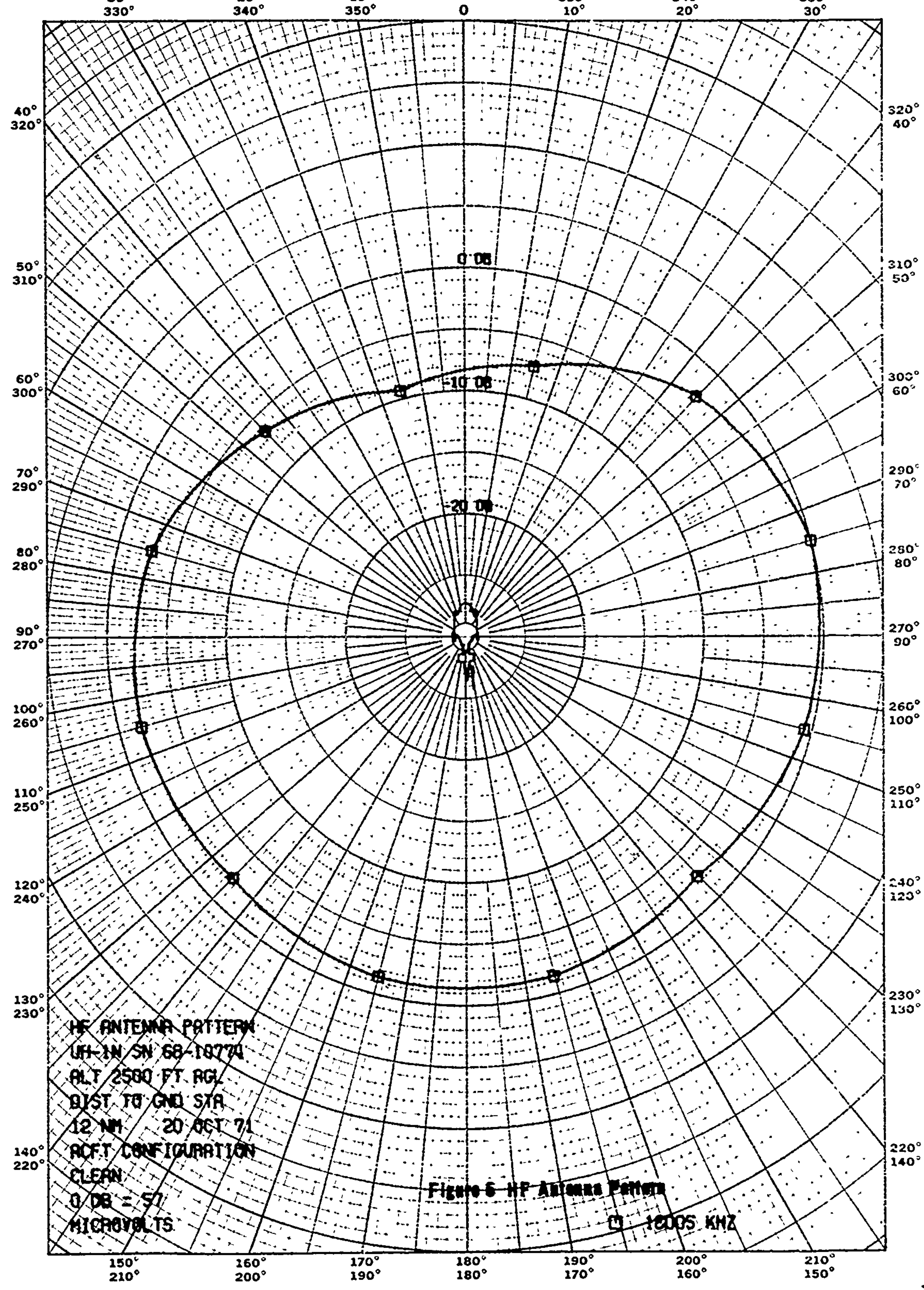


Figure 6 HF Antenna Pattern

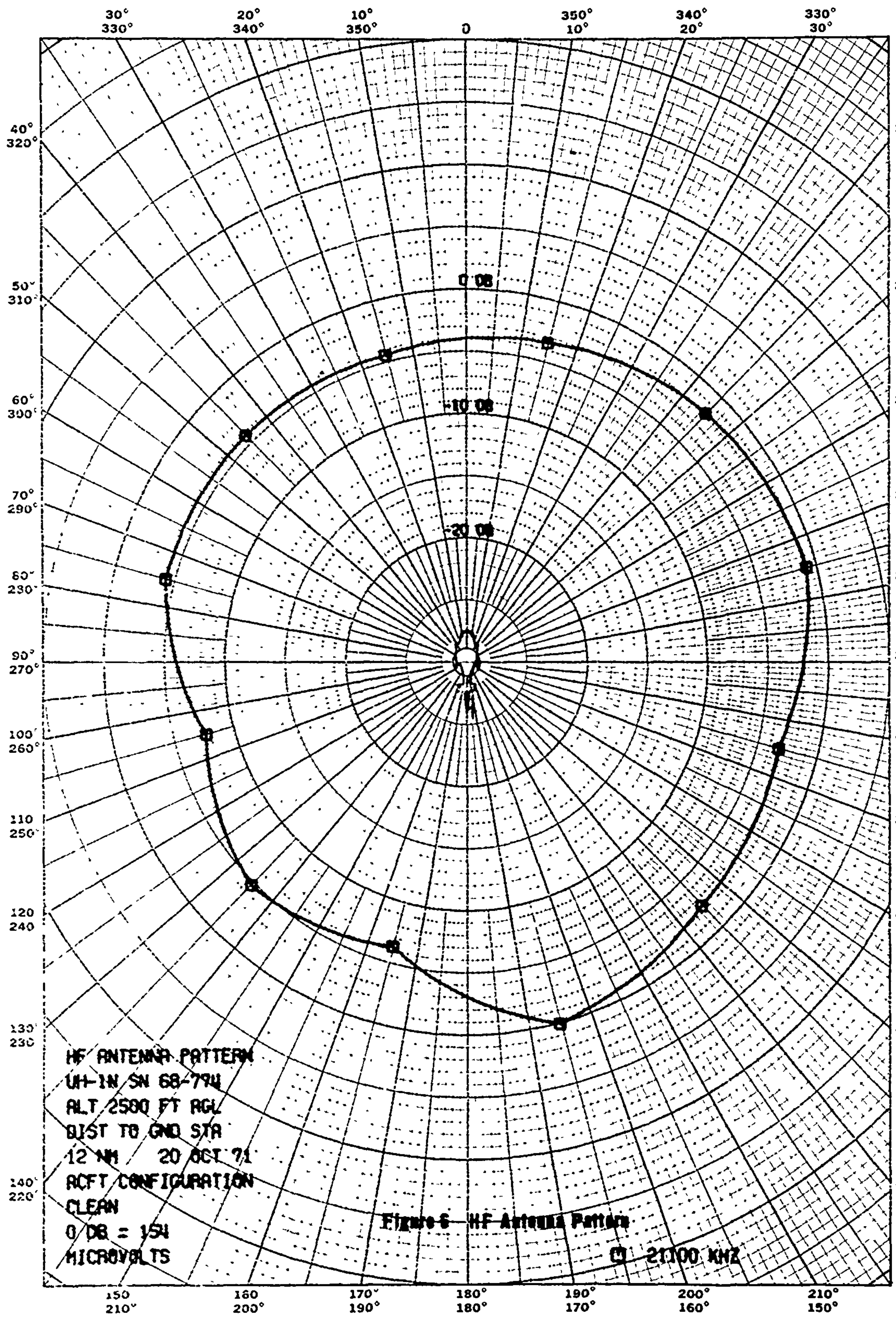


Figure 6 HF Antenna Pattern

CONCLUSIONS AND RECOMMENDATIONS

The overall antenna patterns were acceptable on all frequencies tested. However, the nulls on the higher frequencies were significant and could cause communication difficulties (weak signal strength) if the station was on the same relative bearing from the aircraft as the pattern null.

1. If communication difficulties (weak signal strength) are encountered, changing the aircraft heading by 90 degrees may improve the transmitter and receiver signal strength. This information should be included in T.O. 1H-1(U)N-1, the UH-1N helicopter Flight Manual.

REFERENCE

1. Helmick, Hugh M., Captain USAF, and Russell, Edward B., Major USAF, UH-1N Category II Airframe and Subsystems Evaluation, FTC-TR-71-37, Air Force Flight Test Center, Edwards Air Force Base, California, November 1971.

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1 ORIGINATING ACTIVITY *(Corporate author)* Air Force Flight Test Center Edwards Air Force Base, California	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP N/A

3 REPORT TITLE

UH-1N Category II Airframe and Subsystems Evaluation (Addendum)

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
Final

5 AUTHOR(S) *(First name, middle initial, last name)*

Alfred H. Boyd

6 REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO OF REFS
March 1972	10	1

8a. CONTRACT OR GRANT NO b. PROJECT NO. c. AFFTC Project Directive 66-49 d.	9a. ORIGINATOR'S REPORT NUMBER(S) FTC-TR-71-37 9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)* N/A

10 DISTRIBUTION STATEMENT Distribution limited to U.S. Government agencies only (Test and Evaluation), January 1972. Other requests for this document must be referred to ASD (SDQH), Wright-Patterson AFB, Ohio 45433.

11 SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
N/A	6510th Test Wing Edwards AFB, California

13 ABSTRACT

The tests described in this addendum were conducted at the Air Force Flight Test Center to evaluate the radiation pattern of the long wire antenna used on the high frequency radio set of UH-1N aircraft. The tests were conducted subsequent to the UH-1N Category II airframe and subsystems evaluation because difficulties with the HF impedance matching network, CU-1658A, precluded completion of the test on UH-1N S/N 69-6610. A two-flight evaluation was conducted with UH-1N S/N 68-10774 to obtain the data presented in this addendum. This addendum completes the testing of the AN/ARC-102 high frequency radio set.

UNCLASSIFIED
Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
UH-1N helicopter airframe and subsystems evaluation						

UNCLASSIFIED
Security Classification

FTC-TR- 71-37

FTC-TR- 71-37

AFFTC

UH-1N CATEGORY II AIRFRAME AND SUBSYSTEMS EVALUATION

HUGH M. HELMICK
Captain, USAF
Project Engineer

EDWARD B. RUSSELL
Major, USAF
Project Pilot

TECHNICAL REPORT No. 71-37

NOVEMBER 1971

Distribution limited to U.S. Government agencies only (Test and Evaluation), October 1971. Other requests for this document must be referred to ASD (SDQH), Wright-Patterson AFB, Ohio 45433.

AIR FORCE FLIGHT TEST CENTER
EDWARDS AIR FORCE BASE, CALIFORNIA
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE

FTC-TR-71-37

UH-1N CATEGORY II AIRFRAME AND SUBSYSTEMS EVALUATION

HUGH M. HELMICK
Captain, USAF
Project Engineer

EDWARD B. RUSSELL
Major, USAF
Project Pilot

Distribution limited to U.S. Government agencies only (Test and Evaluation), October 1971. Other requests for this document must be referred to ASD (SDQH), Wright-Patterson AFB, Ohio 45433.

FOREWORD

This report presents systems evaluations and operational analyses of airborne subsystems carried out during Category II testing of the UH-1N helicopter at the AFFTC. The program was conducted under the authority of AFR 80-14 and was requested by ASD (ASZTH) letter, subject "UH-1N Category II Testing by AFFTC", dated 21 August 1969. It was authorized by AFFTC Project Directive 69-49, dated February 1969, under Program Structure 443N.

The following named personnel contributed to the Category II subsystems evaluation covered in this report:

Communications Engineer - Mr. Russell D. Brown

Navigation Engineer - Mr. Alfred H. Boyd

Reliability and Maintainability Engineer - Robert H. Crutcher, Staff Sergeant, USAF

Personnel Subsystems - Richard S. Dunn, Captain, USAF

Foreign announcement and dissemination by the Defense Documentation Center are not authorized because of technology restrictions of the U.S. Export Control Acts as implemented by AFR 400-10.

Prepared by:

Hugh M Helmick

HUGH M. HELMICK
Captain, USAF
Project Engineer

Edward B. Russell

EDWARD B. RUSSELL
Major, USAF
Project Pilot

Reviewed and approved by:

13 October 1971

James W Wood

JAMES W. WOOD
Colonel, USAF
Commander, 6510th Test Wing

Robert M. White

ROBERT M. WHITE
Brigadier General, USAF
Commander

ABSTRACT

UH-1N subsystems tests were flown with three Category II test helicopters. The aircraft was found capable of performing its mission adequately. The airframe, fuselage compartment, flight controls and electric utility system were found to be generally acceptable. Mechanical tail rotor pitch control problems and crew reach difficulties with seat armor installed were notable exceptions. The rescue hoist and cargo suspension unit operated satisfactorily. The loudspeaker system kit proved largely ineffective even after correction of circuitry problems. Early VHF-AM and UHF communications shortcomings were effectively corrected by a TCTO. The AN/ARC-102 receiver-transmitter became inoperative and did not become operational in time for completion of tests. Most other avionics equipment, including navigation aids, proved satisfactory although specifications for such equipment often were not met. Reliability and maintainability figures for onboard systems were determined. The powerplant, transmission, electrical power, flight instruments, VHF-AM transceiver, tacan and UHF-DG systems were identified as reliability problem areas. Engine access was difficult and time consuming and changes to engine cowling and baffle fasteners were recommended.

table of contents

list of illustrations

list of tables

list of abbreviations and symbols

Item	Definition
ADF	automatic direction finder
AGE	aerospace ground equipment
AGL	above ground level
AH/DAY	active hours per day that the aircraft was available for flying and/or maintenance
A_i	inherent aircraft availability
ALTSTG	altimeter setting
AM	amplitude modification
BDHI	bearing distance heading indicator
BHC	Bell Helicopter Company
CDPIR	crash data position indicator recorder
DF	direction finder
DG	directional gyro
DME	distance measuring equipment
ECP	engineering change proposal
FCA	frequency control and analysis
FCF	functional check flight
FH/FLT	number of flying hours per flight
FLT/DAY	number of flights per day
FM	frequency modulation
HF	high frequency
Hz	Hertz
IFF	identification friend foe
IFR	instrument flight rules

Item	Definition
kHz	kiloHertz
KIAS	knots indicated airspeed (kt)
LCL	lower confidence limit
MAG	magnetic
MAPI/PI	mean active hours required to complete a phase inspection
MART/FLT	mean active hours to repair the aircraft between sucessive flights
mhz	megaHertz
MMH/FH	maintenance manhours per flying hour
MPR	monthly progress reports
MSL	mean sea level
MTBA	mean time between aborts (hrs)
MTBD	mean time between discrepancies (hrs)
MTBF	mean time between failures (hrs)
NAF	Naval Air Facility
PACF	Prototype Aircraft Checkout Facility TS-762A/UPM-92
N_a	number of missions on which an abort was recorded against the system
N_d	number of missions on which degraded operation was recorded against the subsystem
N_f	number of missions on which a no-abort failure was recorded against the subsystem
PI/FH	number of phase inspections per flight hour
PSTE	personnel subsystems test and evaluation
R	number of failures accumulated
RF	radio frequency
R&M	reliability and maintainability
rms	root mean square
RT	receiver-transmitter
SEDS	Systems Effectiveness Data System
SEP	systems evaluation program
SOF	Special Operations Forces
T	total system operating (flying) time (hrs)
tacan	tactical air navigation
TCTO	time compliance technical order
UHF	ultra high frequency
UMR	unsatisfactory materiel report
VHF	very high frequency

Item	Definition
VOR	VHF omnidirectional range
VORTAC	VHF-omnidirectional range/tactical air navigation
VSWR	voltage standing wave ratio
WUC	Work Unit Code
α	acceptable risk of error or probability of error
χ^2	chi-square statistic
$1-\alpha$	confidence level

INTRODUCTION

This report presents results of the UH-1N Category II airframe and subsystems evaluation conducted at AFFTC between 14 October 1970 and 16 August 1971. The systems evaluation program was completed in 87 flights totaling 124.9 hours on UH-1N aircraft S/N's 69-6610, 68-10774, and 68-10776. Propulsion and armament subsystems test results are published in references 1 and 2. Other portions of the test program outlined in the UH-1N Category II Systems Test Plan (reference 3) were considered better suited to completion during climatic phases of the test program and have been or will be presented in the all-weather reports. These tests include:

1. Appendix A-4, Section I, paragraph B-4, Water Leakage Test

2. Appendix A-4, Section V, Environmental Control and Protection

3. Appendix A-6, Mission Profiles

Results of other UH-1N tests, including icing, tropical, climatic laboratory, desert climatic, performance and flying qualities evaluations are listed as references 4 through 10. The remaining unpublished climatic reports will contain any further significant developments in the areas discussed in this report.

The Air Force Preliminary Evaluation of the UH-1N (reference 10) contains conclusions and recommendations concerning many of the areas covered in this report. Those not yet acted upon or otherwise affected are still applicable and should be implemented. They will not be reiterated here. **(R 1)**[1]

[1] **Boldface numerals preceded by an R correspond to the recommendation numbers tabulated in the Conclusions and Recommendations section of this report.**

PROGRAM OBJECTIVES

The objectives of the system evaluation program (SEP) were to fly the UH-1N under operational conditions to determine the functional adequacy, operational limitations, and reliability and maintainability figures for the aircraft systems. These objectives were to be attained in compliance with Section B, Part 6 of AFR 80-14, 24 February 1967.

AIRCRAFT DESCRIPTION

The UH-1N helicopter was the military version of Bell Helicopter Company's commercial Model 212 which was developed from the U.S. Army UH-1D. The primary mission of the UH-1N, termed the special operational forces (SOF) mission, consisted of counterinsurgency, unconventional and psychological warfare operations. It was further intended for service in logistical, airfield security personnel transport, rescue and medical evacuation roles.

The UH-1N featured reduced main and tail rotor tip thickness, tractor tail rotor operation, and provisions for the SOF mission kits, including armament, rescue, and psychological warfare subsystems. The aircraft was powered by a T400-CP-400 power package consisting of two PT6T-4 free turbine engines coupled through a combining gearbox to the main transmission. Load sharing and single engine operation were possible with this power system. The helicopter had a maximum forward airspeed of 130 knots, and a maximum gross weight of 10,500 pounds, depending on flight conditions. Further descriptive information may be found in T.O. 1H-1(U)N-1 (reference 11).

TEST AND EVALUATION

This section presents test results listed under subsystem title. Each subsystem evaluation contains a brief hardware description, test objectives, ground and flight test results, and conclusions and recommendations.

Only major deficiencies or those areas not considered adequately documented elsewhere are discussed in the following sections. Unsatisfactory materiel reports (UMR's) were submitted per T.O. 00-35D-54 (reference 12). UMR's listed in appendix I do not include those submitted in other UH-1N technical reports. Additional information on UMR action status can be obtained from ASD (SDQH), Wright-Patterson AFB, Ohio 45433. Specific recommendations in each UMR are not necessarily repeated in the Conclusions and Recommendations section. Those deficiencies cited in UMR's which remain open should be acted upon. **(R 1)**

Evaluations of aerospace ground equipment (AGE) were made during normal usage. Specific tests were not conducted, but use of this equipment was monitored by personnel subsystems test and evaluation (PSTE) and engineering personnel. Specific AGE deficiencies are discussed in the body of the report. Reliability and maintainability (R&M) of the UH-1N were evaluated on a subsystems monitor basis throughout the program.

Bases for R&M data were derived from all three aircraft involved in the Category II program except as noted in the R&M section in this report.

AIRFRAME

General

Description.

The airframe structure was essentially the same as that of other UH-1 aircraft. The fuselage consisted of two semi-monocoque sections. These were the forward fuselage section and the tail boom. The forward fuselage was built up around two longitudinal beams. These were the primary structural members in the aircraft, supporting the cabin floor, alighting skids, transverse bulkheads, propulsion components, and tail boom. Aluminum was the primary construction material with fiberglass being used in selected components such as fairings. The tail boom supported the tail rotor, vertical fin, synchronized elevator, and tail skid.

Test Objectives.

The objectives of the airframe evaluation were to:

1. Monitor any important aircraft structural failures caused by fatigue, abrasion, or corrosion.

2. Determine any serious problems encountered in changes from the previous UH-1 models, including personnel subsystems areas.

3. Determine the adequacy of airframe AGE equipment.

Test and Evaluation.

No tests were specifically conducted for airframe components. Maintenance efforts on the airframe were monitored throughout the program. An analysis of airframe maintenance requirements is included in the R&M section of this report. Human engineering evaluations are included in the PSTE section of this report.

Specific Deficiencies.

Ground handling of the UH-1N was often difficult and time consuming. The ground handling wheels were a source of trouble for the ground crew due to the frequent need to repair the hydraulic lift system in each wheel pair. Interference between the LAU-59A rocket launch system and the wheels required the reversed-position installation of wheels (as compared to instructions in reference 13). Instructions for mounting the ground handling wheels should be supplemented to allow reversed-position installation. (R 2)

With wheels installed, a ground crew member was required to depress the tail skid to raise the front of the alighting skids clear of the pavement. This required up to 150 pounds of downward force, depending on aircraft cg. Ground movement over long distances, required continuous manual depression of the tail skid making movement slow and tedious. The ground handling system should be improved to facilitate more rapid movement of the aircraft. (R 3)

Armor panels on pilot and copilot seats interfered with entry and egress from the aircraft as well as inflight crew functions. Normal entry and egress to either seat was difficult and time consuming. Crewmembers equipped with back-pack parachutes found egress a precarious operation. This was especially difficult from the left side of the cockpit, where the copilot had to clear the collective lever as well as armor. Simulated emergency egress from this seat required an average of 25 seconds.

Armored seats also presented clearance problems associated with the use of the collective levers and both pilot's and copilot's access to the pedestal console and the overhead circuit breaker panel. Control reach in all three areas required abnormal effort for all personnel who flew the aircraft, with the most severe problem being experienced by short individuals who normally had to fly with their seats moved forward. These persons had to move their seats back to reach aft console controls and circuit breakers. Seat armor should be modified to correct these problems. Hinged side seat panels are a possible solution. **(R 4)**

Flight Controls and Hydraulics

Description.

Main and tail rotor controls were actuated through mechanical linkages by a mechanical-hydraulic boost system. The hydraulic boost was effected by two independent systems operating parallel to each other for system redundancy. In event of dual hydraulic failure, shut-off valves retained hydraulic fluid inside the actuators to allow continued manual inputs to aerodynamic controls. The tail rotor boost was supplied by only one of the two systems. A complete description of the system can be found in references 11 and 13.

Test Objectives.

Test objectives were to:

1. Determine the cause and effect of any significant flight control malfunctions.

2. Determine vulnerability/survivability of flight controls.

Test and Evaluation.

Operation of the flight control system was monitored during normal use throughout the Category II program.

Specific Deficiencies.

All three Category II aircraft had tail rotor pitch control difficulties during the program. In each case, rudder pedal stiffness and binding occurred in flight. Pedal reaction was described as "momentary lock-up". In all three cases, the lower-aft bearing of the tail rotor pitch control lever part number (P/N 209-011-712-1) was found in a seized condition. UMR's R71-79 (open), R71-252 (open), and R71-257 (open) were submitted. Similar pedal binding symptoms occurred on aircraft 774 and

610 when tail rotor pitch-change push tubes (P/N 209-011-710-5) evidenced a buildup of dirt and corrosion. Another tail rotor deficiency was discovered during a 200-hour phase inspection of aircraft 776 when abrasion was found on a push tube (P/N 212-001-052-1). This had been caused by a Teflon guide intended to support the tube. Emergency UR E71-336 (open) was submitted.

Examination of system design and layout indicated that hydraulic system redundancy would probably be effective only for internal mechanical failures of one of the two systems. The proximity of hydraulic system components in the transmission compartment makes survival of a single system unlikely in event of battle damage. Armor plate protection of this vital area should be incorporated. **(R 5)**

Flight controls and the associated hydraulic systems were generally satisfactory except for the tail rotor problems.

Electrical System

Description.

The primary source of electric power on the UH-1N was a pair of 30-vdc, 200-ampere starter-generators, each driven by one of the aircraft engines. Each starter-generator was capable of supplying power to start the engine associated with the other unit. The onboard 24-volt, 34-ampere-hour battery or a ground power unit could be used for starting. The battery could also supply emergency power for a short interval. A complete description of the system and its operation is given in reference 11.

Test Objectives.

Objectives of the electrical system evaluation were to:

1. Confirm proper operation of the system design.

2. Determine functional adequacy of the system from an operational standpoint.

Ground Tests.

The electrical systems of all three Category II aircraft were monitored during normal ground operations, including battery and ground power starts. Engine starting current was greater than the 300 ampere maximum scale on dc ammeters, but the duration of this high current was short and no adverse effects were observed. No other discrepancies were noted.

Flight Tests.

Airborne engine starts were made during the propulsion phase of the program using both battery and generator power sources. Airborne electrical system operation was monitored during all phases of the program and was found adequate. Switching functions and overload protection were adequate. The overall aircraft electrical system operation was satisfactory.

Specific Deficiencies.

A generator balancing problem occurred on aircraft 774. It was characterized by occasional spontaneous loss of output from either generator, with the remaining unit assuming the full electrical load. Load balancing procedures described in aircraft T.O.'s were accomplished, but did not correct the malfunction. Detailed examination of the balancing circuitry revealed that paralleling rheostats (P/N M22-03-0011 UB) had been wired in reverse by the manufacturer. This did not preclude proper operation, but reversed the direction of the balance adjustments. Reversal of rheostat adjustment direction eliminated the problem. T.O. procedures in reference 12 pertaining to this problem should be revised to specify that the control be turned in the direction of minimum electrical resistance. **(R 6)**

When a starter-generator was being used in the start mode, the appropriate GEN light capsule in the annunciator panel extinguished, regardless of the position of the associated generator switch. This gave the pilot an indication that the particular unit involved was operating in the generator mode when in fact it was not. Pilot references to the ammeter could clarify the situation; however, this detail might easily be missed under high workload. An example of the potential hazard can be seen during an attempted engine restart in flight. If the pilot placed the generator switch in the OFF position as required by the checklist, subsequent starter activation would extinguish the dc generator caution light. If the starter switch was not disengaged at 50-percent gas-producer rpm and the engine was then accelerated to match torque indicators, normal flight indications would return although one starter-generator remained in the starter mode. The dc warning system should be redesigned to cause illumination of the generator caution light any time a particular generator is not providing power to the aircraft. **(R 7)**

Auxiliary Equipment

The UH-1N featured built-in provisions to accommodate several accessory kits. These kits enabled the aircraft to perform the SOF missions. The following items were tested during the subsystems phase of the test program.

Internal Rescue Hoist.

Description

The BL8300 rescue hoist which was tested was an electrically powered device designed to lift or lower up to 600 pounds to a maximum of 256 feet. The hoist consisted of a vertical column, winch with cable and hook, boom and pulleys, and base plate with linear actuator. It could be installed in any of four corner stations of the cargo compartment. In operation the boom could be rotated between the interior and exterior of the aircraft. This motion, and the up-down speed of the cable were controlled by switches on the hoist operator control pendant or by a control switch atop the right cyclic control stick. A cable-cutting guillotine was incorporated into the hoist boom. In an emergency this could be actuated by the hoist operator via CABLE CUT switch located on the hoist control box, or by an equivalent switch on the pedestal console. A system of warning lights was incorporated to indicate when the

hoist was operating within 20 feet of either end of cable travel. Limit switches stopped cable motion at full extension and retraction.

Test Objectives

The objectives of the rescue hoist test were to:

1. Confirm the proper operation of the system as designed.

2. Determine the operational suitability of the system.

3. Establish duty cycle information on the hoist.

Ground Test

The hoist system was installed in the aircraft in the forward right station of the cargo compartment (figure 1). Ground power was applied to the aircraft. All control functions were exercised, including cable retraction and extension, and hoist boom translation. All control actions were adequate.

The suspension hook on this hoist featured a two-piece assembly intended to retain attached accessories. The main hook closure was spring loaded in the closed direction (figures 2 and 3). A safety clasp was provided to prevent inadvertent opening of the main closure. This clasp was held in place by dimples stamped into its sides. These were not adequate to retain the clasp reliably. With the clasp open, it was found that the forest penetrator could be twisted so as to push the main closure aside, releasing itself from the hook. Such a condition is likely to occur during impact with the ground or tree branches, causing possible loss of the penetrator. A positive locking hook closure should be incorporated to eliminate this possibility. **(R 8)**

An explosive squib was installed in the cable-cutting guillotine in preparation for flight tests. Installation checkout of the electric detonation circuit showed it to be operational from both switch positions. No test of the guillotine was attempted. The electric power for the detonation of the guillotine squib was taken from the nonessential dc bus. While nonessential power was always available through manual switch controls, a delay in hoist jettison caused by switch selection may not be tolerable during an inflight emergency. Electrical wiring should be changed so that the cable-cutting quillotine squib is fired by the essential bus. **(R 9)**

Flight Test

The hoist was installed in the forward right station (figure 1). Hoist cable load was provided in the form of lead shot ballast weighing 250 pounds. The hoist motor was operated at its highest speed during most of the test. Temperature indicator tapes were located on the hoist gearbox casing and drive motor. Extension and retraction of the hoist boom were exercised between the lift cycles. A 30-second cooling period between operations was allowed per the Flight Manual. One flight was made performing a series of hoist operations summarized in table I.

As lift cycling progressed, considerable temperature rise was observed in the drive motor and gearbox. These components became too hot to touch. During the seventh lift cycle, the gearbox pressure relief vented a stream of hot oil which narrowly missed the hoist operator. Temperature of the gearbox at the time was between 190 and 220 degrees F. The test was terminated shortly thereafter to investigate this problem. The cause was determined to be due to the combined effects of gearbox oil over-service and the accumulation of heat.

All functions of the hoist, including both sets of controls, and the 20-foot warning light system operated properly during the test.

The warning lights did not have provisions for dimming. During night operation the light on the instrument panel would be blinding to the pilot. Some means for controlling light brightness should be incorporated. (R 10)

The Flight Manual specified duty cycle information for 600-pound loads only. This information would be of little use since most hoist operations required repeated cycling at lower weights. This information should be expanded to include cycle limits for more typical hoist operations. (R 11)

The tests performed were not sufficient to fully satisfy the duty cycle objective. Further hoist tests were conducted during the desert weather phase of the UH-1N Category II program, and results are presented in reference 7.

Loudspeaker System Kit.

Description

The SA-1800C kit was a high-power sound system intended for air-to-ground communications. It consisted of an RMC-3 remote control unit, a DP-3 power distribution panel, three MA-600 (600-watt) audio amplifiers, and a B24-PT loudspeaker. These components were assembled on a frame which was mounted on the left side of the UH-1N cargo area via floor receptacles. The loudspeaker could be extended outside the aircraft after the left cargo door had been opened or removed. Power for the unit was supplied from the nonessential bus by an outlet provided in the left cabin wall.

In operation, either a hand-held microphone or a Sony TC-800B tape recorder could be used as audio signal sources. Amplitude of this signal was controlled by the RMC-3 control unit which distributed the signal to the three power amplifiers. Outputs from the amplifiers each drove an array of eight audio drivers within the B24-PA loudspeaker.

Test Objectives

Objectives of the tests were to investigate operational suitability of the system including effectiveness and proper operation.

Ground Test

A preflight functional check was made with the system installed in the aircraft. Upon initial application of power to the system, the LOUD SPKR circuit breaker on the aircraft circuit breaker panel tripped. Inspection and bench checks revealed that the main power leads to the system were reversed at the loudspeaker power panel plug, causing a direct short to ground. An audio plug required for connection of the tape recorder was missing. Disassembly of the system revealed loose solder, nuts, washers, and deviations of circuitry from technical manual diagrams (reference 14). AFFTC UMR 71-399 (open) was submitted.

After correction of the above discrepancies, bench test procedures for adjustment of the system and measurement of power output were successfully carried out using T.O. procedures. It was determined that at the aircraft utility voltage of 28 vdc, maximum combined power output was 1,520 watts. Correct phasing among the speaker driver units was confirmed.

Power output of the system was less than the published value, but was considered representative of the full capabilit of the system. A sound level survey was made around the aircraft with the SA-1800C in operation. Results of this test are presented in the PSTE section of this report.

The TC-800B tape recorder failed during preparation of a recorded message for use in flight tests. Technical Orders for this machine did not exist, nor was a circuit diagram available. It was repaired by removal of miscellaneous loose solder particles and washers.

Flight Test

Two flights were made to evaluate the effectiveness of the system. Ground observers were placed at a single location. The area used was free of any substantial amount of vegetation or other sound absorbing media. The aircraft was flown about the vicinity under varying conditions while the SA-100C was operated. Both microphone and tape recorded voice sources were used.

Any use of SA-1800C systems already manufactured should be preceded by thorough examination and bench tests. Future manufacture of the unit should include functional tests and improved quality control. (R 12), (R 13)

Initial operation revealed that helicopter flight noise was a serious cause of sound interference to listeners on the ground. Noise of the UH-1N was judged to be approximately as loud as the loudspeaker system it carried. Subsequent bench checks showed that 5 of the 24 loudspeaker driver units were inoperative. Failed units had voice coil lead failures. These were repaired and the above stated power output level (1,520 watts) was confirmed.

Sound feedback with the handheld microphone caused early termination of the above test. An oxygen mask was modified and fitted to the system microphone as a measure to reduce audio feedback. This subsequently permitted an increase in power level. Continued flight testing

showed some improvement in intelligibility, although the loudspeaker and helicopter sound levels were still approximately equal in intensity. An enclosed anti-feedback microphone should be incorporated into this system. **(R 14)**

Air-ground communication was possible only when the loudspeaker was aimed in the direction of the listener. As a consequence, the most practical flight pattern was a left-hand circle made at a low airspeed. Speech could be heard up to a radius of approximately one-half mile and an altitude of 500 feet. Further increase of altitude or radius did not permit reasonable message comprehension.

High-pitched voice material was more easily understandable than low-pitched. Slow speech was essential for understanding. Microphone and tape recorder were judged equal in effectiveness. Wind severely hindered system effectiveness by carrying sound downwind and causing noise in the ears of listeners.

Power output measurements indicated that the system was operating at or near its rated capability. Based on this information and test observations, it was concluded that the SA-1800C had only very limited operational usefulness because of short range. This was primarily due to the high level of UH-1N flight noise.

External Cargo Suspension Unit.

Description

The UH-1N external cargo hook was a full swiveling and swinging type attached near the aircraft cg. It featured manual release capability available to the pilot, and an electrically actuated release triggered by a switch on both pilot and copilot cyclic control stick handles. Electric release was armed by actuation of an overhead toggle switch marked CARGO RELEASE. Manual release was actuated by means of a footpedal located between the pilot directional control pedals. Hook lift design capability was 5,000 pounds, subject to aircraft flight limitations.

Test Objectives

Objectives of the cargo hook tests were to confirm proper operation under load and to determine if any adverse operational characteristics would be encountered in the transport of external loads via cargo hook.

Flight Test

The aircraft lifted and translated to forward flight with concrete deadloads weighing 200, 1,000, and 2,000 pounds (figure 4). All hook release controls were tested. Release was confirmed with the 200 pound load deflected in all four directions beneath the aircraft. Aircraft handling with these loads was explored at up to 80 KIAS.

No difficulty was encountered in cargo operations from aircrew or ground crew standpoints. Flight Manual and T.O. instructions were adequate. All release functions operated properly. Good releases were still obtained with the hook load deflected out of vertical to the limit

of the hook-swing bumper. Hook swivel about its vertical axis was observed with all three loads. Operation of the system was satisfactory.

COMMUNICATION EQUIPMENT

The UH-1N was equipped with three receiver-transmitter (RT) radio sets as standard equipment. These were the AN/ARC-116 ultra-high frequency (UHF-AM), AN/ARC-115 very high frequency (VHF-AM), and AN/ARC-114 VHF frequency modulation (VHF-FM). Provisions were built into the aircraft for the AN/ARC-102 high frequency (HF) radio set. Distribution of onboard intercommunication, radio, and navigation audio signals was accomplished by a C-6533 intercommunication system.

None of the aircraft communications radios had a preselect channel selector capability or a remote channel/frequency indicator on the forward instrument panel. There was no capability to transmit on VHF or UHF guard frequencies (121.5 mHz, 243.0 mHz) with absolute minimum effort in emergency situations. On the AN/ARC-115 and AN/ARC-116 control panels, all desired frequencies (including guard frequencies) had to be set in individually. This required excessive time and effort by the pilot to the extent that the pilot capability to safely control the aircraft could be compromised. The single-point guard-transmit capability was considered mandatory. UHF and VHF radios should provide preselect channel capability including radio guard-transmit channels. **(R 15)**

The AN/ARC-115 and AN/ARC-116 systems originally shared a common antenna system on the UH-1N. Due to unsatisfactory performance, the antenna system design was changed through Bell Engineering Change Proposal (ECP) 568E. This change affected both RT units similarly. For this reason and because of similarities in testing of the units, test results for both units are presented together.

AN/ARC-115 and AN/ARC-116 Receiver-Transmitters

VHF-AM Receiver-Transmitter AN/ARC-115, Description.

The ARC-115 provided two-way amplitude modulation (AM) narrow band voice communications on 1,360 frequency-synthesized digitally-tuned channels between 116.000 and 149.975 megahertz (mHz), with a power output of approximately 9 watts. A separate guard receiver capability was included to monitor the 121.50 mHz VHF emergency frequency. Both of the receivers were disabled during transmitter operation. The radio control box was marked VHF AM COMM and was mounted on the left side of the pedestal. Power was supplied by the 28-vdc dc essential bus and protected by a 5-ampere circuit breaker identified as VHF-AM.

The VHF command radio transmitter and main receiver operated on the same frequency and were simultaneously tuned by two frequency selector knobs mounted on the front panel of the AN/ARC-115. When the function selector switch was in the T/R GUARD position the fixed-tuned guard receiver was energized to provide constant monitoring of the VHF emergency frequency regardless of the main radio frequency setting. The aircraft VHF antenna (UHF VHF AT-1108 ARC) was used for transmission and reception.

UHF-AM Receiver-Transmitter AN/ARC-116, Description.

The ARC-116 was designed to provide two-way UHF amplitude modulated (AM) voice communications on 3500 channels within the frequency range of 225.00 to 399.95 megahertz (mHz). Design power output was approximately 9 watts. A guard receiver was incorporated in the set and was fixed tuned to 243.00 mHz. Both receivers were disabled during transmitter operation. The radio set was marked UHF-AM and was a single unit mounted on the center pedestal. Power was supplied by the 28-vdc essential bus and protected by a five ampere circuit breaker labeled UHF-AM.

The UHF command radio transmitter and main receiver operated on the same frequency and were simultaneously tuned by frequency selector knobs mounted on the front panel. When the function selector switch was positioned to T/R GUARD the fixed tuned guard receiver was energized to provide constant monitoring on the UHF distress frequency regardless of the main receiver-transmitter frequency setting.

Pre-ECP Antenna System Description.

An AT-1108 (Collins type 37R-2U) antenna (shared by both systems) was mounted on the fuselage roof over the pilot's compartment. This antenna featured elements for both VHF and UHF frequencies in one blade-type housing. Type RG-58U interconnecting coaxial cable was used. A pair of band-pass radio frequency (RF) filters were incorporated to suppress harmonic interference between these units and other equipment on the aircraft.

Test Objectives.

The test objectives for the ARC-116 and ARC-115 were to determine:

1. The functional adequacy of the units.

2. The antenna radiation patterns.

3. The maximum communication range.

4. Operation with ECP 568E incorporated.

Pre-ECP Ground Test

Power output and reflected power measurements were taken with a Bird Thruline Wattmeter (Model 43) at the output of the RT and at the antenna. The voltage standing wave ratio (VSWR) was computed from the power measurements made at the antenna. Results are shown in table II.

The VHF-AM system failed to meet specification SCL-T-0045B (reference 15). On 10 frequencies tested, only 2 met the minimum power output of 9 watts measured the RT unit. On three frequencies, VSWR at the antenna was greater than 3:1.

The UHF-AM system met those parts of specification SCL-T-0046B (reference 16) regarding power output at the RT unit and VSWR at the antenna input. Power losses between the RT unit and the antenna were unacceptable.

Pre-ECP Flight Test.

Maximum Range

Maximum range tests for both the UHF and VHF-AM radios were conducted over water between the ground station and the aircraft at altitudes and distances listed in table III. Both radios had deficient maximum range and did not meet maximum range specifications in references 15 and 16.

Antenna Patterns

Antenna radiation patterns were measured while flying a 12-heading cloverleaf pattern at 27 NM from the ground station at 2,500 feet above ground level (AGL). Each system was tested at high, medium and low frequencies. Signal strength was so weak on UHF-AM at 27 NM range that reliable, usable signals could not be received at the ground station. The aircraft was then flown to 1 nautical mile distance and 2,500 feet AGL and a 12-heading cloverleaf flown. A strong signal was obtained at this position. The results of the antenna pattern tests are shown in figures 5 and 6. The criterion for an acceptable antenna pattern for these sets (per SCL-T-0045B and SCL-T-0046B) was, "no more than 58 percent of nulls shall be more than 6 db below than the pattern maximum". The patterns for frequencies 135.05 mHz and 141.55 mHz did not meet specification and were not acceptable. The antenna patterns for frequencies 124.05 mHz and 304.0 mHz, while acceptable per specifications, were marginal because of the large decibel loss in several of the nulls.

Post-ECP Antenna System Description

As a result of Category I findings and those of using units in the operational commands, Bell ECP 568E was incorporated on UH-1N S/N 60-6610 under TCTO 1H-1(U)N-506. Modifications to the aircraft included exchanging positions of the AT-1108/ARC antenna and the forward formation light. This located the antenna away from nearby obstructions. An AT-256/ARC UHF antenna was installed on the chin of the aircraft. Coaxial cables were changed from RG-58U to RG-303U, and RF filters were moved to shorten required cable lengths.

Post-ECP tests were then performed to determine effect on UHF and VHF-AM performance.

Post-ECP Ground Test.

Ground tests were performed in the same manner as in pre-ECP ground tests. The VHF-AM power output on the 10 frequencies tested was 9 watts or greater at the RT, and the VSWR was acceptable; the largest VSWR was 2.21:1 measured at the antenna (table IV). Specification SCL-T-0045B (reference 15) was met. Table V presents the percentage increase in power measured at the antenna for each frequency. The average power output improvement for all frequencies observed was 81 percent.

AN/ARC-116

ARC-116 power output and VSWR test results are presented in table VI. Power output on 7 of the 11 frequencies tested at the RT failed to

satisfy specification. The VSWR measured at the antenna did satisfy the specification. Percentage improvements for the 11 frequencies tested are presented in table VII. An overall average of 35-percent improvement in power to the UHF antenna was observed over the frequency range.

Post-ECP Flight Test.

Maximum Range

Each RT unit was operated at low, middle and high frequencies within their respective bands. The maximum range test was conducted by having the aircraft fly outbound from a ground receiving station at 3,100 feet pressure altitude, approximately 800 feet AGL. A radio check was conducted each minute until radio contact was lost. The aircraft was then climbed to the next altitude where contact was resumed, and continued outbound repeating the process. Distance from the ground station was measured by tacan distance measuring equipment.

AN/ARC-115

Table VIII shows results of maximum range communication tests conducted between the UH-1N aircraft and an AN/ARC-73 communication set located at the ground station. The ground station used an AT-104 antenna system with a 100-foot RG-58U coaxial cable feed; power output was 20 watts. Testing was accomplished using the operational requirement of reliable two-way communication with squelch operating at 35 NM and 1,200 feet AGL as a standard. Ideally, maximum range tests should be conducted over level terrain to determine the effect of the earth curvature and signal absorption near the ground station. The terrain over which these tests were conducted was such that it was impossible to obtain a line of sight distance of 35 NM without encountering hills, buttes, and mountains. The maximum range obtained at 1,200 feet above ground station was 28 NM. At this point the aircraft was at an altitude of approximately 200 feet AGL in a mountainous area. The aircraft could not proceed outbound without climbing to clear the immediate terrain. To remain at 1,200 feet above the ground station it was necessary to change course. Shortly thereafter, intervening hills prevented communication. The aircraft climbed to 2,500 feet above the ground station and communication was re-established. This meant that the maximum range observed was a function of line-of-sight radio path and not of the transmitter output or the receiver sensitivity. The maximum range of the VHF-AM radio set was satisfactory.

AN/ARC-116

Table IX shows results of communication maximum range tests conducted with an AN/GRA-53 radio set mounted in a mobile van and an AT 197/GR antenna mounted on the roof of the van; power output was 20 watts. Testing was accomplished using the operational requirement of reliable two-way communication with squelch operating at 35 NM and at an altitude of 1,200 feet AGL as a standard. A test was performed on two frequencies (260.7 mHz and 378.1 mHz) with the ground receiving station at an altitude of 3,125 feet above mean sea level (MSL); the operational requirement was met. However, on 304.0 mHz, with the ground station located at a lower altitude of 2,322 feet MSL, it was not possible to maintain line-of-sight radio path to a distance of 35 NM at 1,200 feet AGL. For this reason, the specified distance requirement could not be demonstrated.

The aircraft climbed to 2,700 feet above the ground station and communications were established. The maximum range of the UHF-AM radio set was considered satisfactory.

Antenna Pattern

Antenna radiation pattern characteristics were measured for both RT units at the same frequencies used in the maximum range tests. Twelve-heading patterns were obtained for both units at 27 NM range and 2,500 feet AGL. In addition, a pattern at 2 NM and 2,500 feet AGL was made with the ARC-115 to investigate the possibility of fuselage masking. A 1,000 Hz tone was transmitted through the unit being tested while relative signal strength was recorded at a ground station equipped with a receiver calibrated to read zero decibel for a 1-microvolt signal at its input.

AN/ARC-115

Specification SCL-T-0045B required that no more than one half of the VHF-AM pattern nulls may be more than 6 decibels below the maximum signal strength. Figures 7 and 8 show the antenna radiation patterns obtained. It was noted that at the 2-NM distance the nulls were considerably less pronounced and coverage was excellent in all quadrants.

AN/ARC-116

Figure 9 shows the antenna radiation pattern obtained with the ARC-116 at 27 NM and 2,500 feet AGL for 260.7 mHz, 304.0 mHz, and 378.1 mHz. The radiation patterns met the required criteria and were acceptable.

AN/ARC-114 Receiver-Transmitter

Description.

The ARC-114 provided two-way FM narrow-band voice communications on 920 digitally-tuned channels on VHF frequencies between 30.00 and 75.95 mHz. It also featured a homing capability on these frequencies. Nominal transmitter output power was 9 watts. Guard receiver capability was included in the radio set to monitor the 40.50 mHz FM emergency frequency. The set consisted of the following units: AN/ARC-114 radio set, ID-387/ARN course indicator, and an antenna coupler (BHC P/N 204-075-320). An FM antenna (AS-1703)(AR) was used with the transmitter and guard receiver, and either this antenna or the homing antenna Bell Helicopter Company (BHC) P/N 205-075-345 was used with the main receiver. Secure communications were possible when the secure-voice encoder/decoder (TSEC/KY-28) was installed in the aircraft. The homing function of the FM supplied inputs to the course indicators which provided visual steering indications for homing on the received signal. Warning flags were provided in the course indicators to inform the pilot and copilot that an adequate homing signal was not being received. The ARC-114 had the additional capability for retransmission of communications when a second set was installed in the aircraft. The voice security and retransmission capabilities were not available for use on the test aircraft. The radio set was marked VHF-FM COMM and was mounted on the pedestal. Primary power was supplied by 28-vdc protected by a 5-ampere circuit breaker identified as VHF-FM.

The FM radio transmitter and receiver operated on the same frequency and were simultaneously tuned by frequency selector knobs mounted on the front panel of the ARC-114. When the function selector switch was in the T/R GUARD position, a fixed tuned-guard receiver was energized to provide constant monitoring of the FM emergency frequency regardless of the radio frequency setting. During normal communications, the aircraft VHF-FM antenna was used for transmission and reception.

Test Objectives.

The test objectives for VHF FM communication were to determine:

1. The functional adequacy of the unit.
2. The antenna radiation pattern.
3. The maximum communication range.
4. The adequacy of the homing function.

Ground Test.

Power output and reflected power measurements were performed using a Bird Thruline Wattmeter (Model 43) at the output of the RT and at the antenna. Results of these tests are shown in table X. The power output on the ten frequencies tested at the RT was 9 watts or greater, and the VSWR's were acceptable. Specification SCL-T-0044B (reference 17) was met

Flight Test.

Maximum Range

The frequencies and altitudes under which the test was conducted are listed in table XI. The maximum range test was conducted by having the aircraft fly outbound from the receiving station at 3,100 feet pressure altitude (approximately 800 feet AGL). A radio check was conducted each minute until radio contact was lost. The aircraft was flown to the next test point altitude. The distance from the ground station was determined by tacan distance measuring equipment.

Table XI shows results of maximum range communication tests conducted with a PRC-25 portable FM ground communication set located at the ground station. The PRC-25 had a power output of 2 watts, using either a 3- or 10-foot antenna. For this test, the 10-foot antenna was employed. Testing was accomplished using the operational requirement of reliable two-way communication (with squelch operating) at 35 NM and 1,200 feet AGL as a standard. A test was performed on two frequencies (39.95 mHz and 49.95 mHz) with the ground receiving station at an altitude of 3,125 feet MSL; the operational requirement was met. On 75.75 mHz, with the ground station located at a lower altitude of 2,322 feet MSL, it was not possible to maintain line-of-sight radio path to a distance of 35 NM at an altitude of 1,200 feet AGL. For this reason, the specified distance altitude requirement could not be demonstrated. The aircraft flew to 2,700 feet above the ground station and communications were re-established. The maximum range of the VHF-FM radio set was satisfactory.

Antenna Pattern

One flight was made to evaluate the VHF-FM antenna radiation characteristics at frequencies near the lower, middle, and upper end of the frequency band. Tests were conducted at 34.95 mHz, 49.95 mHz and 75.75 mHz. The altitude for this flight was 2,500 feet AGL. The distance from the aircraft to the receiving station was 22 NM. Data for the three frequencies were recorded when the aircraft was stabilized on each heading of a 12-heading cloverleaf pattern flown over a ground identification point. The pilot transmitted a 5-second 1,000 Hertz tone on the VHF-FM radio set and the relative signal strength was recorded at the ground station using a receiver calibrated to read zero decibel for a 1-microvolt signal at its input.

Figure 10 shows the antenna radiation pattern obtained at 22 NM and 2,500 feet AGL for 34.95 mHz, 49.95 mHz, and 75.75 mHz. The radiation patterns met specification criteria and were acceptable.

Homing

VHF-FM homing tests were conducted on 34.95 mHz and 75.75 mHz using the AN/PRC-25 as a ground station. The ground station was located on a hill at an altitude of 3,100 feet MSL overlooking a valley with an average altitude of about 2,500 feet MSL. The aircraft started the test at an altitude of 4,200 feet pressure altitude over a point 18 NM [illegible] the ground station. The magnetic bearing to the ground station [illegible] the starting point was 077 degrees.

On 34.95 mHz the initial heading from the starting point was 072 degrees. The ground track was a direct path to the receiver with the aircraft passing directly over the ground station. As the aircraft approached the ground station, the indicating bar became very sensitive and was impossible to follow within the last 1/4 mile. On the outbound heading, the indicator became nondirectional, giving position indication that the ground station had been passed.

On 75.75 mHz the initial indicated heading was 095 degrees. Upon reaching the ground station, the heading was 055 degrees with the aircraft passing approximately 50 yards south of the ground station. The ground track was to the south of the direct path. The same station passage and outbound indications were observed on this frequency as on 34.95 mHz.

The Flight Manual did not discuss course deviation indicator (CDI) sense, ambiguity solution, sensitivity indicator function, and station passage indications. These were vital to the successful use of the FM homing function. The Flight Manual should be revised to provide more detailed procedure and information on the VHF-FM homing function. **(R 16)**

The signal strength indications displayed on the horizontal bar of the ID-347/ARN were not sensitive enough to indicate the approach of the ground station. The horizontal bar was deflected only one-half scale downward when over the ground station. The system indicated maximum downward off-center needle displacement when maximum signal strength was received. Thus, close to the target transmitter, where maximum signal strength was received, the indicator displayed a full off-center

deflection. This was opposite to the on-target (or desired track) indications provided by the ID-387/ARN course indicator during tacan or VOR modes and caused unnecessary confusion. The ID-387/ARN signal strength presentation for the VHF-FM homing function should be changed to display maximum signal strength with the glideslope needle centered, and the sensitivity of the indicator should be increased. **(R 17)**

AN/ARC-102 Receiver-Transmitter

Description.

This receiver-transmitter provided transmission and reception of single-side-band AM and continuous wave signals within the HF range of 2.000 to 29.999 mHz on any of 28,000 channels. The HF set was intended for both air-to-air and air-to-ground two-way communications, and consisted of the following units: Receiver-transmitter Unit RT 698/ARC-102, Power Static Inverter PP-3702 ARC-102, HF Control Unit C3940 ARC-94, HF impedance matching network (antenna coupler), and Antenna Kit BHC P/N 212-706-004 (HF longwire). The RT was composed of 11 plug-in modules, which included an interchangeable internal power supply. The complete unit was enclosed in a metal case. The RT was controlled from the control panel installed in the pedestal. Primary power to operate the RT was supplied from the helicopter 28-vdc essential bus. The HF antenna coupler automatically matched the impedence of the longwire antenna to the frequency selected on the remote control unit.

Test Objectives.

The objectives were to determine:

1. The functional adequacy of the unit.

2. The antenna radiation pattern.

Ground Test.

After installation, the AN/ARC-102 was operationally ground tested using McClellan AFB and a C-5A flying near Hawaii as a point of contact. Communications were established using upper side-band mode. McClellan AFB and the C-5A reported that the audio was excellent.

The antenna kit (HF longwire) was designed to be used on the "D" model helicopter instead of the "N" model, and it did not allow the left cargo door to open fully without physical contact with the antenna. This condition may lead to antenna breakage or an RF short circuit. The antenna fuselage feed-through should be moved to correct this situation. **(R 18)**

Shortly after this test, antenna coupler CU 1658/A became inoperative and remained out of commission for the remainder of the program. For this reason, tests on the ARC-102 were very limited. Further ARC-102 tests should be conducted. **(R 19)**

C-6533/ARC Audio Distribution Control Panel

Description.

The C-6533/ARC audio control panel provided an intercommunication capability between the crewmember stations. Crewmembers could select any one of four RT's for voice communications; additional audio circuits could also be monitored. The system allowed selection and monitoring of up to seven receiver circuits. A complete description of the system is given in reference 11.

Test Objective.

The test objective was to determine the functional adequacy of the system.

Test Method and Analysis.

The C-6533/ARC interphone was evaluated qualitatively throughout Category II testing. One significant deficiency was noted: during gunfiring it was impossible for the pilot to communicate with the gunner due to the proximity of the gunner's microphone to the weapon system. The pilot and copilot could communicate satisfactorily, and communication to ground and other aircraft by radio was possible during firings provided the gain control on the radio was advanced above normal listening level. Type HGU-2P helmets were worn by crewmembers on armament missions; tests should be conducted using different types of helmets and microphones to determine whether or not communication would be possible under actual combat conditions. **(R 20)**

NAVIGATION EQUIPMENT

The UH-1N is equipped with a full complement of navigation aids, including those required for instrument flight rules (IFR) flights. This section describes tests, results, and evaluations of these systems.

AN/ASN-43 Gyromagnetic Compass System

Description.

The gyromagnetic compass system consisted of the following units: CN-998( )/ASN-43 Directional Gyro, T-611( )/ASN Induction Compass Transmitter, CN-405( )/ASN Magnetic Flux Compensator, C-6347( )/ASN Compass Controller, AM-6015/A Electronic Control Amplifier, two ID-663C/U Bearing Distance Heading Indicators and two ID-387( )/ARN Course Indicators.

The system provided a visual indication of the aircraft magnetic heading on the bearing distance heading indicator (BDHI) compass card. When operated in the magnetic mode, the system indicated magnetic heading because the directional gyro was slaved to the earth's magnetic meridian by the Induction Compass Transmitter. When operated in the directional gyro (DG) mode the DG was not slaved to the compass transmitter and the BDHI indicated aircraft heading based on the DG reference. The system was provided with a synchronizing knob on the compass controller which operated as a heading-set knob in the DG mode and as an alignment

knob in the magnetic mode. The annunciator indicated when the DG was aligned with the induction compass transmitter.

Test Objectives.

Test objectives were to determine the heading accuracy of the magnetic mode and drift rate in the DG mode.

Ground Test.

Compass swing tests were conducted on 24 headings, every 15 degrees, on the AFFTC compass rose. The actual aircraft heading was determined using a Kollsman B-16 sighting compass with an accuracy of ±2 degrees. Table XII shows the compass swing data obtained for aircraft 774. The deviation of 1 degree was acceptable.

Flight Test.

The directional gyro drift rate was measured on four test missions in which accurate heading information was not required to perform the primary mission. The missions flown varied, but in general a large number of turns were performed. First the DG was aligned to the magnetic heading (before takeoff). The clock time was noted when the system was placed in DG mode. The primary mission was flown. After the aircraft had landed, but before engine shutdown, the heading was noted while the system was still in DG mode. The clock time was recorded and the system was switched back to magnetic mode and the synchronizing knob was used to align the annunciator to its center position. The magnetic heading was recorded. The difference between the final magnetic heading and the indicated DG heading at the end of the mission, divided by the time the system was operating in the DG mode, gave the drift in degrees per hour.

The test data collected are shown in table XIII. Reference 13 requires that the drift rate in the DG mode be less than 5.5 degrees per hour. The directional gyro-compass drift rate was acceptable.

AQU-5A Magnetic Compass

Description.

The AQU-5A magnetic compass (standby) was mounted above the right windshield and was used with the compass correction card located on the center post between the two windshields. The XM60 sight was mounted to the immediate right of the standby compass.

Test Objectives.

Test objectives were to determine compass accuracy and the effect of the XM60 sight on the compass calibration.

Ground Test.

The standby compass was tested concurrently with the ASN-43 gyromagnetic compass using the compass rose at AFFTC. The actual aircraft heading was determined with a Kollsman B-16 sighting compass

Reference 13, paragraph 11-151, page 11-70, requires that maximum deviation not exceed ±8 degrees. Table XIV lists the accuracy test data obtained for the compass on aircraft 774 with the XM60 sight removed. This compass did not meet this requirement. Table XV contains the accuracy test data for the compass on aircraft 610 with the XM60 sight removed. The maximum deviation without the sight exceeded the ±8 degree specification. Table XVI gives the accuracy test data for the compass on aircraft 610 with the XM60 sight installed. The maximum deviations were within the ±8 degree specification. Installation of the XM60 sight affected the compensation of the AQU-5A. The compass should be recompensated whenever the sight is installed or removed, and the T.O. should be amended to reflect this requirement. **(R 21)**

The AQU-5A magnetic compass was located above the windshield on the pilot side of the aircraft. In this position, it could be seen only with difficulty by the pilot and not at all by the copilot. The XM60 sight was mounted approximately 2 inches to the right of the compass. When the sight was in the stowed position it completely blocked the pilot's view of the compass. The AQU-5A Magnetic Compass should be relocated where it can be seen by both the pilot and copilot and where it will be free from the magnetic influence of the XM60 sight. **(R 22)**

AN/ARA-50 UHF-AM Direction Finder System

Description.

The system consisted of the following components: AM-3969/AR RF Amplifier, AM-3624/ARA-50 Relay Amplifier, and the AS-909/ARA-48 DF Antenna. The DF was a lightweight airborne direction finding system which operated in the UHF frequency range of 225 to 400 mHz. The system used outputs from the receiver section of the AN/ARC-116 UHF receiver-transmitter to determine the relative bearing from the aircraft to any transmitter operating in the UHF frequency range. The system could be used for course navigation, search and rescue operations, or for determining the relative bearing of other aircraft. Bearing information was displayed on the No. 1 pointer of the BDHI units.

Test Objectives.

The test objectives were to determine the bearing accuracy and functional adequacy of the homing function.

Flight Test Method and Analysis.

The DF system was tested using a Navy UHF radio beacon located at China Lake Naval Air Facility (NAF), Ridgecrest, California, and by transmitting a signal from the AFFTC frequency control and analysis (FCA) van located at the approach end of Rogers Dry Lake, runway 23, at Edwards Air Force Base, California. The aircraft was flown over a ground reference point that was 27 NM from China Lake NAF on a radial of 197 degrees from China Lake. The ground reference point was 22 NM from the FCA van on a radial of 348 degrees from the van. The frequency of the UHF beacon at China Lake NAF was 265.2 mHz and the FCA van transmitted on 304.0 mHz and 378.1 mHz. The indicated bearings to each station were recorded while

flying a 12-heading cloverleaf pattern at 6,000 feet pressure altitude (approximately 4,220 feet above the ground stations) over the ground reference point.

The UHF DF system was also used to locate a crash data position indicator recorder (CDPIR) that had been inadvertently ejected from another aircraft. The search for the CDPIR was started approximately 10 NM from the actual location of the CDPIR. The initial heading took the aircraft to the right of the CDPIR location. The DF system indicated station passage when the aircraft was alongside the CDPIR. A left turn was executed and a second station passage indicated the immediate area where the CDPIR was found. A total search time of about 15 minutes was required to locate the CDPIR.

Table XVII shows the results of the bearing accuracy tests for 265.2 mHz, 304.0 mHz, and 378.1 mHz. Figure 11 shows the UHF DF error relative to the aircraft heading. The average deviation for the three tests indicates that the error was consistently positive at 045 degrees, 076 degrees, and 136 degrees. The error was consistently negative at 010, 105, and 200 degrees. This indicated that there were disturbances due to the airframe which affected all three test frequencies. The system did not meet the bearing accuracy specifications of ±7.00 degrees root mean square (RMS) value in MIL-D-38402, reference 18.

DF Homing

Homing tests were conducted on 308.7 mHz using a 10-watt vehicular mounted ground station and on 264.0 mHz using a modified AN/URC-4 emergency transmitter for a ground station. The ground stations were located on a hill at an altitude of 3,100 feet MSL overlooking a valley with an average altitude of 2,800 feet MSL. The homing tests were conducted at 4,200 feet pressure altitude over a point 18 NM from the ground station. The magnetic bearing to the ground station from the starting point was 077 degrees.

The initial bearing for 308.7 mHz was 073 degrees and the final bearing was 068 degrees. The aircraft followed an S-path to the ground transmitter and passed 25 yards south of the transmitter. Station passage was indicated approximately 100 yards past the ground station. The AN/URC-4 hand-held emergency transmitter was modified to shift its frequency from the emergency frequency of 243.0 to 264.0 mHz. Power output of this transmitter was approximately 100 milliwatts. The signal was not received until the aircraft was 5 NM from the ground station at 5,000 feet pressure altitude. Homing from this point inbound was satisfactory. Station passage indication was satisfactory. The UHF-DF system homing capability was usable; however, additional testing should be performed to determine the reason for bearing inaccuracy and to determine corrective action for the problem. **(R 23)**

AN/ARN-65 Tacan Navigation System

Description.

The AN/ARN-65 tacan system consisted of: RT-471/ARN-65 Receiver-Transmitter, C-1763/ARN-21A Control Unit, AT-741/A Antenna, two ID-387/ARN Course Indicators and two ID-1103/ARN Bearing Distance Heading Indi-

cators. The tacan audio was routed through the NAV switch position on the C-6533/ARC Audio Control Panel to aircrew headphones.

This set was an airborne navigation set which operated in conjunction with tacan ground beacons. The airborne and ground sets formed a radio navigation system that enabled the aircraft to receive continuous indications of its distance (up to 195 NM) and magnetic radial from any tacan beacon within reception range. The tacan system operated in the L-band frequency range on any of 126 preset tacan channels. It was controlled through the tacan control panel and information from the system could be displayed on both pilot and copilot course indicators and the No. 2 pointer of each BDHI. The tacan-VOR switch allowed presentation of VOR information on the instruments when the tacan system was not being used.

Test Objectives.

The tacan system was evaluated to ascertain the accuracy of the radial determinations, the distance indications, and the maximum range at which valid tacan signals could be received.

Flight Test.

DME and Radial Accuracy

To evaluate the accuracy of the tacan distance measuring equipment (DME) and radial indications, the test aircraft was flown on a triangular course in the vicinity of Edwards AFB at 10,000 feet pressure altitude. As the aircraft traversed the course, its flightpath was recorded by a tracking radar. The radar data was computer processed to determine the aircraft latitude and longitude at 1-second intervals. Seven tacan stations were used during the test. Throughout the flight the pilot periodically tuned in each of the tacan stations to read the indicated radial from the course indicator and the distance from the BDHI. The pilot also notified the tracking station when data were being taken so the time could be accurately recorded. The radar tracking data and the published coordinates of the tacan stations were used to calculate the actual radial as well as distance from the aircraft to the stations.

The data resulting from the radial accuracy test are shown in table XVIII. The error for each tacan station represents the average of 12 individual readings taken at 6-minute intervals. Radial and distance accuracy of the tacan system were operationally satisfactory.

Antenna Evaluation

At any point on a tacan radial the number 2 BDHI indication should be the same regardless of aircraft heading; if it is not, aircraft antenna pattern irregularities are the probable cause. In order to investigate the antenna pattern, the error data was grouped into 12 30-degree segments of a circle. The average error for all data points in each segment was calculated and plotted on polar coordinates. The resulting pattern would reveal antenna-related problems in tacan operation. Figure 12 shows the tacan radial error and figure 13 shows the DME error relative to aircraft heading. The test was conducted under actual operating conditions using tacan channel numbers between channels 21 and 108. The

aircraft-to-station distance varied between 7 and 70 NM. No significant antenna-related inaccuracy was discernable.

Maximum Range

Tacan maximum range tests were conducted near Bakersfield, California, in the San Joaquin Valley, using tacan stations located northwest of Bakersfield. This location provided line-of-sight radio paths of 200 miles to several stations without terrain interference. The test was conducted by tuning in a station and then descending until break-lock occurred. The test was conducted on both inbound and outbound headings relative to the stations. The acceptable maximum range was calculated as a function of distance and altitude above the station.

The UH-1N was not normally operated at altitudes above 10,000 feet MSL; however, the tacan maximum range specification (reference 18) was stated only for altitudes of 10,000 through 40,000 feet above the tacan stations. These requirements were extrapolated to altitudes below 10,000 feet using UHF maximum radio path distance data from reference 20. For altitudes between 10,000 and 40,000 feet AGL, the range requirements averaged 80 percent of maximum radio path distance. Therefore, the required range for altitudes below 10,000 feet was assumed to be 80 percent of maximum radio path distance for each altitude. Table XIX shows the results of the tacan maximum range test for radial lock and table XX shows results of the test for DME lock.

The demonstrated maximum range of the tacan system exceeded 80 percent of the maximum radio path distance at all test points. This range was considered satisfactory.

AN/ARN-89 Automatic Direction Finder System

Description.

The automatic direction finder (ADF) system consisted of the following individual components: R-1496 ( )/ARN-89 Radio Receiver, C-7392( )/ARN-89 ADF Control Unit, AM-4859( )/ARN-89 Impedance Matching Amplifier, AS-2108( )/ARN-89 Loop Antenna, BHC P/N 205-075-325 Sense Antenna, and two ID-1103/ARN Bearing Distance Heading Indicators. The receiver audio was routed through the NAV switch position on the C-6533/ARC Audio Control Panels to the headphones.

The ADF provided the pilot and copilot with visual indications of the relative bearing to a radio station. The ADF radio bearing indications could be used for homing and obtaining radio navigation fixes. The information was displayed on the BDHI No. 1 pointer. The receiver featured continuous tuning over the frequency range of 100 to 3,000 kHz, and it incorporated three modes which allowed it to function as an ADF, a manual DF, or as an AM receiver. A beat frequency oscillator was included to provide an audible indication of unmodulated carrier signals.

Test Objectives.

The ADF system was evaluated to determine the accuracy of the bearing indications, the homing capabilities, the accuracy of station passage indications, and the accuracy of navigation fixes.

Ground Test.

Ground tests were limited to adjustment of the system. ADF systems are affected by distortion of the radio frequency (RF) field pattern caused by structural components of the aircraft. The R-1496/ARN-89 Radio Receiver was equipped with a goniometer which compensated for this distortion. Compensation procedures detailed in reference 21 were used to adjust the goniometer. Compensation data required for adjustment was obtained from reference 22.

The goniometer unit installed in the aircraft had not been compensated by the aircraft manufacturer before installation. Table XXI lists the bearing obtained before and after compensation at AFFTC. Note that the R-1496 Radio Receiver must be compensated with data applicable to the UH-1N aircraft before use in the UH-1N aircraft. This data should be applicable to all UH-1N aircraft unless a major change is made in the configuration of the aircraft. Reference 21 gives detailed test procedures for determining the compensation data for an aircraft if the data were not available.

Flight Test.

Bearing Accuracy

Twelve-heading cloverleaf patterns were flown over a ground reference point approximately 14 NM from a 20-watt low frequency aeronautical beacon transmitter operating on 282 kHz, a 5,000-watt broadcast station operating on 610 kHz, and a 1,000-watt broadcast station operating on 1,380 kHz. The actual bearing to the transmitter station was measured from an aeronautical chart for comparison with the indicated bearings on each heading of the cloverleaf pattern. Figures 14 through 16 show plots of the data obtained. The average value of the error was -5.25 degrees for 282 kHz, -4.25 degrees for 610 kHz, and -3.00 degrees for 1,380 kHz. Reference 19 states that bearing errors may not exceed ±5 degrees of actual bearing to the station. The ADF system did not meet the specified accuracy requirement on any of the test frequencies; however, the consistent negative difference between the actual bearings and the indicated bearings revealed that a system error existed that could be removed by recalibration. Additional testing should be conducted to determine proper compensation settings for the ADF system. **(R 24)**

Homing

To evaluate the homing capability of the ADF system, the ADF was tuned to the ground transmitter at a distance of approximately 22 NM. The aircraft was flown toward the station using only ADF for steering. Station passage was indicated when the ADF BDHI pointer moved thru 90 degrees from flightpath heading. The approach to the 282 kHz radio beacon was flown at 2,000 feet AGL and was satisfactory. The aircraft passed over the transmitter location, and station passage was indicated approximately 2,000 feet past the station. The approach to the 610 kHz station was also flown at 2,000 feet AGL and was satisfactory. Station passage was indicated approximately 3,000 feet past the station after the aircraft passed directly over the station. When used in the homing mode, ADF system performance was satisfactory.

Radio Fix

The ADF was used to obtain a radio fix using two broadcast stations located at approximately 50 NM distance. The two bearings indicated were plotted on an aeronautical chart and compared to a tacan fix from a local tacan station. Table XXII shows results of plotting the ADF and tacan data. The average radial error for three fixes was 4.6 NM which was acceptable for an ADF fix at this range. The ADF system performance was satisfactory for navigation fixes.

AN/ARN-82 VHF Navigation System

Description.

The VOR radio receiver consisted of the following units: R-1388/ARN-82 Radio Receiver, C-6823/ARN-82 Control Unit, AS-1304/ARN VOR Antenna, two ID-387/ARN Course Indicators, and two ID-1103/ARN Bearing Distance Heading Indicators. The VOR audio was routed through the AUX switch position on the C-6533/ARC Audio Control Panels to the crew headphones.

The AN/ARN-82 detected VOR and instrument landing system (ILS) localizer signals in the frequency range of 108.00 to 117.95 mHz. These signals were used to provide continuous indication of the magnetic radial from a VOR ground station or course indications from an ILS localizer signal. The receiver could also be used to receive communication signals in the frequency range of 118.00 to 126.95 mHz. The VOR and ILS signals were displayed on the course indicator and the VOR signals were also displayed on the No. 2 pointer of the BDHI units. The tacan-VOR switch enabled the indicators to display course and radial information from the tacan system when the VOR receiver was not being used (reference 23).

Test Objectives.

The objectives of VOR receiver tests were to determine the accuracy of radial and ILS localizer indications, and the maximum range at which VOR signals could be received.

Flight Test.

The VOR receivers in the three Category II aircraft displayed a continuous oscillation in BDHI presentations of the VOR radial. The No. 2 pointer in each BDHI unit typically oscillated from ±3 degrees to ±10 degrees about the correct radial. Oscillations varied from approximately one to three cycles per second, and precluded an accurate reading of the instrument. The BDHI indication was unsatisfactory. The oscillation in the BDHI display of the VOR receiver should be investigated to determine its source and the effect on receiver accuracy; the VOR installation should be modified to reduce the oscillation to an acceptable level. **(R 25)**

The condition was most severe when the aircraft was headed inbound toward the station and was at a minimum when outbound. The course deviation indicator presentation was not affected; thus the system was tested using the CDI.

VOR Radial Accuracy

To evaluate the accuracy of the course deviation indications of the VOR receiver, the aircraft was flown on a triangular course in the vicinity of Edwards AFB at 10,000 feet pressure altitude. As the aircraft traversed the course, its position was tracked by radar. The radar data was recorded and computer processed to provide the latitude and longitude position at 1-second intervals throughout the flight. The pilot periodically tuned each of five local VOR stations and recorded the indicated radial from the course indicator. The pilot also notified the radar tracking station when data was being taken so the time could be accurately recorded. The radar tracking data and the published latitude - longitude coordinates of the VOR stations were used to calculate the actual radial from the VOR station to the aircraft.

The data from the VOR radial accuracy test are shown in table XXIII. The error for each VOR station represents the average of the absolute value of 12 individual readings taken at approximately 6-minute intervals. The radial accuracy specification was not met; however, the VOR radial accuracy was operationally satisfactory using the CDI.

Antenna Evaluation

At any given point on a radial the indicated VOR radial should be the same regardless of aircraft heading; if it is not, aircraft antenna pattern irregularities are the probable cause. To investigate this, the error for each data point was grouped into 12 30-degree segments of a circle. The average error for all data points in each segment was calculated and plotted on polar coordinates. The resulting pattern revealed antenna-related problems in VOR operation. Figure 17 shows the VOR errors relative to aircraft heading. The test was conducted under actual operating conditions using five VOR stations on frequencies between 108.4 and 116.4 mHz. The distance between the aircraft and the VOR station varied between 7 and 70 NM. The VOR antenna system was found satisfactory.

VOR Maximum Range

The maximum range for VOR reception was measured near Bakersfield, California, in the San Joaquin Valley, using VOR stations located northwest of Bakersfield. This location provided line-of-sight radio paths without interference from hills or mountainous terrain. The tests were conducted by tuning in a VOR station and then descending until the signal became unusable. These tests were conducted on both inbound and outbound headings to the station. The acceptable maximum range was calculated as a function of distance and altitude above the VOR station.

No specific reference for the maximum range required could be located. Since the VOR and tacan radial functions are similar in mission requirements, it was assumed that the VOR maximum range should be equal to the tacan maximum range requirements. Table XXIV shows the results of the VOR maximum range tests for usable radial information. The test demonstrated that the maximum range of the VOR receiver exceeded the 80 percent of the line-of-sight radio path distance at all test points. This was adequate range for navigation requirements.

ILS Localizer

To evaluate the ILS localizer function of the systems, the aircraft was flown in both level and normal descent approaches along the Edwards AFB ILS localizer beam. The pilot attempted to keep the course indicator centered at all times. The aircraft was tracked with a tracking radar and its position relative to the localizer beam (extended runway center line) was plotted. The radar data plots are shown in figures 18 and 19. The maximum deviation from the centerline was approximately 200 feet. During the final 1.5 miles of the approach the deviations were negligeble. The ILS localizer receiver function of the ARN-82 VOR receiver was satisfactory.

AN/APN-171(V) Radar Altimeter System

Description.

The AN/APN-171(V) Radar Altimeter System was an electronic low-level altitude indicating system intended to provide indications of precise altitude above ground level (AGL) from 0 to 5,000 feet. The radar altitude was displayed to both pilot and copilot on ID-1345/APN-171(V) Height Indicators. The indicators featured a manually set, low-level warning lamp to warn that a predetermined low altitude limit had been reached. The RT-804/APN-171(V) Receiver-Transmitter radiated pulses of C-band microwave energy downward and measured the time required for the echo to return from the terrain below the aircraft, using a leading edge electronic tracking loop which locked onto the radar range of the terrain nearest the aircraft.

Two AS-1858/APN-171(V) Antennas were used for transmitting and receiving the RF energy. They were mounted on the lower surface of the tail boom.

The ID-1345/APN-171(V) Height Indicators included a black and yellow striped flag which indicated loss of altitude tracking and/or loss of power. The system had a self-test feature to check its operation by depressing the push-to-test knob located on the lower left corner of the altitude indicator. The pointer indicated 100 $\pm$15 feet when the system was functioning properly. Rotation of the knob also turned on the system and changed the low-level warning lamp limit index.

Test Objective.

The objective of this test was to determine the accuracy of the AN/APN-171(V) Radar Altimeter System.

Flight Test

Accuracy tests of the system were made while flying over Rogers Dry Lake. The AFFTC phototheodolite tracking range was used to measure the aircraft altitude in the 500 to 5,000 feet AGL range. A calibrated fly-by tower was used to measure the altitude in the 10 to 300 foot AGL range. The accuracy of the data from the fly-by tower and the Askania range were both approximately $\pm$3 feet.

Table XXV shows data obtained during the calibrated flights. Each data point was repeated three times and the results were averaged. The limited number of data samples precluded a determination as to whether the errors were system errors or random errors. Specified accuracy requirements of ±5 feet or ±3 percent, whichever was greater, were met at all test altitudes (reference 24).

The possibility existed for the radar altimeter to detect radar energy reflected from a sling load under the aircraft and thus display the distance to the load rather than to the ground. A 55-gallon drum was attached to a 90-foot rope and tests were conducted in hover and at 60 KIAS. During this test the altimeter operation was not affected by this sling load; however, the possibility of lock up still exists for larger sling loads. A NOTE should be placed in the Flight Manual stating that the radar altimeter may possibly lock up on a sling load rather than the terrain. Based on accuracy requirements stated in reference 24, the radar altimeter was operationally satisfactory. (R 26)

R-1041()/ARN Marker Beacon Receiver

Description.

The marker beacon receiver system included the R-1041( )/ARN Marker Beacon Receiver, AT-640( )/ARN Antenna, and indicator lamps which were part of ID-387/ARN Course Indicators.

The marker beacon receiver was a fixed-frequency 75 mHz receiver which provided the pilot and copilot with visual and aural indications for determining when the aircraft was within the radiation pattern of a 75 mHz marker beacon transmitting station. When the aircraft was within the beacon radiation field, the marker beacon indicator lamp on the course indicator flashed in response to modulation of the marker beacon signal. The audio signal received from the beacon was routed through direct inputs of the audio control panels to aircrew headsets. The HIGH-LOW-OFF switch, located on the pilot TACAN-VOR panel, selected the sensitivity of the marker beacon receiver, and controlled dc power to the receiver. When the switch was placed in the LOW position, receiver sensitivity was reduced to more closely define the position of the aircraft when operating at low altitude.

Test Objective.

The marker beacon receiver system was evaluated to determine if it functioned satisfactorily when the aircraft was flown over a marker beacon at altitudes typical of ILS approach procedures.

Flight Test.

The aircraft was flown over the Edwards AFB outer marker beacon at altitudes of 5,000, 1,700, and 500 feet AGL. As the aircraft overflew the marker beacon, its flightpath was recorded by space positioning radar. The pilot reported the beginning and end of audio and light indications from the marker beacon receiver by air-ground radio. The aircraft position at start and stop of indications was marked on the radar plots for later analysis.

Test data are shown in table XXVI. Reference 25 required that the antenna pattern symmetry be such that the duration of marker beacon indication, when approaching a marker beacon station, would be no more than 50 percent greater than the duration of marker beacon indications when leaving a marker beacon station. Thus the ratio of the reception distance before station passage to the reception distance after station passage had to be greater than 0.67 and less than 1.5. The marker beacon functioned satisfactorily at the HIGH and LOW sensitivity settings but the pattern symmetry ratio was slightly less than the specification requirement.

Placing the receiver sensitivity switch in the LOW sensitivity position reduced the flight distance for which tone and light indications were received by approximately one half. Using the LOW sensitivity position at a 5,000-foot altitude resulted in missing the marker beacon indication. A NOTE should be placed in the Flight Manual indicating that the HIGH sensitivity position should always be used above published outer marker altitude. After reaching published altitude, the LOW sensitivity position could be selected to identify the outer and inner markers more accurately. **(R 27)**

AN/APX-72 Transponder Set (IFF)

Description.

The IFF Radar Identification Set permitted automatic identification of the aircraft when interrogated by friendly surface and airborne radar equipment. The RT-859/APX-72 Receiver-Transmitter, AT-741A Antenna, and C-6280(P)/APX Control Panel enabled the aircraft to reply to radar interrogations in modes 1, 2, and 3/A. When the AAU-21A Altimeter-Encoder was installed, encloded pressure altitude data (reference to altimeter setting ALTSTG 29.92) was supplied to the transponder for mode C operation. Installation of the KIT-1A/TSEC, Mark XII Computer enabled mode 4 operation. A TS-1843/APX Test Set provided an inflight test capability of the identification system in modes 1, 2, 3/A, and C by indicating either satisfactory or unsatisfactory system operation. This system also provided a tone input to the audio control panel when valid mode 4 IFF interrogation and replies were present.

Test Objectives.

The objectives of the test were to evaluate the set in accordance with DOD AIMS Document No. 153, reference 26. Level 2 testing was conducted to determine the adequacy of the IFF antenna system and to determine agreement between the altitude indicated by the cockpit altimeter and the altitude reported to the ground via the mode C function. Level M testing was conducted to determine the functional adequacy of the secure IFF mode 4 function. Levels 1, 3, and 4 testing to calibrate the pitot-static system will be documented in the Category II performance report (reference 8).

Ground Test.

To evaluate the full capabilities of the system in all modes, an AAU-21A Altimeter-Encoder and a KIT-1A/TSEC, Mark XII Computer were installed in the test aircraft. The AN/APN-123(V) Transponder Test Set was used to interrogate the identification friend or foe (IFF) system

in modes 1, 2, 3A/C and 4 during ground test.

The following discrepancies were identified and corrected before all the modes of operation could be verified:

1. The wiring harness to connector P916 was short, making the connector difficult to insert into the mating plug on the RT-859/APX-72. This problem also existed on aircraft 774. It was not necessary to rewire the aircraft, but UMR 71-326 (closed) was submitted.

2. When the Mark XII computer was installed in the MT-3951/U Mount, the KIK-18/TSEC Code changer key could not be properly placed to code the computer due to physical interference between the code changer key and the flexible shaft cable used to adjust the position of the copilot directional control pedals. This problem was resolved by removing a 1-inch spacer under a clamp holding the flexible shaft at the floor level, thus allowing the flexible shaft cable to be moved enough to clear the changer key.

3. The test aircraft was originally equipped with AAU-7/A Altimeters. The wiring required for installation of the AAU-21A Altimeter-Encoder was installed on the left (copilot) instrument panel. The two altimeters generally indicated slightly different altitudes, therefore the primary aircraft altimeter should be used to provide data for the mode C function. The aircraft wiring should be modified to provide for installation of the AAU-21A Altimeter-Encoder in the pilot's instrument panel. (R 28)

4. Wiring provisions in the test aircraft provided only 28-vdc power to the Mark XII computer. Mark XII computers in the Air Force inventory required 115-volt, 400-Hz ac power for operation. A Class II modification of the aircraft was incorporated to make ac power available. This was done in advance of Bell engineering's proposed ECP UH-1N 580ER-1[2] which would accomplish the same result. This ECP should be incorporated in all UH-1N aircraft intended for use with this equipment. (R 29)

5. The mode 2 code selection wheels and the Mark XII computer were so located that ground crew personnel had to reach around the directional control pedals to reach or install the Mark XII computer or change the mode 2 code wheels (figure 20). Considering that in combat operations the mode 2 and mode 4 codes may require changing between missions or on a daily basis, these units should be relocated to a position that would improve their accessibility. (R 30)

Code Hold/Zero Function

The code/hold on/off function was tested during ground tests. When the code hold switch was placed in the ON position and the code switch on the C-6280(P) APX control panel was placed in the HOLD position, the mode 4 code was not erased when electrical power was removed. This action

[2]Urgent Action Engineering Change Proposal UH-1N 580ER-1 "To provide ac power for operation of Mark XII computer, KIT 1-A/TSEC, APX-72 System," P2622 OUZ Jan 71, US Army, Bell Plant Activity, Fort Worth, Texas, 27 January 1971.

also illuminated an IFF code hold caution light. When the code switch was placed in the ZERO position, the IFF code was erased and the IFF caution light was illuminated, indicating that mode 4 operation was no longer available. The code hold/zero function system operated satisfactorily during the test.

Flight Test Method and Analysis.

Mode Verification

The Prototype Aircraft Checkout Facility (PACF) TS-1762A/UPM-92 installed at AFFTC was used to interrogate the identification system during flight test. This facility provided a low power ground station capable of interrogating the identification system in all the above modes. Satisfactory reply pulses were identified by a correct reply light. An oscilloscope was also available to verify the pulse codes received.

The aircraft was flown at 10,000 feet MSL within 25 NM of the PACF site. Each mode was interrogated by the PACF with all mode-enable switches in the ON position. The test was repeated with one mode-enable switch at a time switched ON and all other modes switched OFF. Operation of modes 1, 2, 3/A, C, and 4 were verified at the PACF site. Correct operation of the cockpit code selection switches for modes 1 and 3/A were verified at the PACF site. Correct operation of the cockpit code selection switches for modes 1 and 3/A were verified on each digit. Satisfactory operation was obtained in all modes and switch positions.

Antenna Pattern

The radiation pattern of the AT-741A Antenna was measured by flying cloverleaf patterns over a point 15 NM from the PACF, at 10,000 feet pressure altitude. Radar tracking was used to vector the aircraft over the reference point on each heading. The relative signal strength was measured while interrogating the transponder in mode 2. The UH-1N aircraft used one IFF antenna located on the bottom of the aircraft near the rear of the fuselage. The antenna radiation pattern obtained at 90 KIAS (figure 21) was unacceptable due to the deep null off the nose of the aircraft. This null was not observed at 60 KIAS, when the nose-down attitude of the aircraft decreased approximately 4 degrees. An additional top-mounted fuselage antenna with an antenna switching unit should be installed to improve the radiation pattern. **(R 31)**

Altitude Correlation

The aircraft was flown at 1,000-foot altitude intervals between 3,000 and 10,000 feet pressure altitude. While stabilized at each altitude, the PACF altitude readout was recorded. The aircraft was also flown at a constant des[illegible]te of 2,000 feet per minute, starting at a pressure altitude of [illegible]t and descending to 3,000 feet. The pilot radioed the alti[illegible]ed by the AAU-21A when passing thru each 500-foot altitude [illegible] and the ground-reported readout was recorded.

The AIMS requirements for mode C altitude reporting specified that the altitude displayed by the cockpit altimeter and by the ground station agree within ±125 feet (reference 26).

The altitudes reported to the PACF were all within the required ±125 feet; however, the altitudes recorded at the ground station during the test were approximately 50 feet higher than the cockpit-indicated altitude. This error was attributed to a fixed error associated with the encoder section of the AAU-21/U instrument used in the test. Mode C operation was satisfactory.

Maximum Range

The aircraft was flown outbound from the ground station at 10,000 feet pressure altitude until the mode 4 and mode 2 signals were received intermittently. The course was reversed and the maximum range on an inbound heading was determined. The maximum ranges recorded during this test were not representative of the maximum range capabilities when using operational radars to interrogate the transponder, because of the low output power of the PACF.

Using the PACF to interrogate the transponder, the maximum range on an outbound heading was 32 NM. At this range both modes 2 and 4 were equal in signal strength. When the aircraft was on an inbound course the maximum range was 20 NM at 60 KIAS airspeed and 15 NM at 90 KIAS airspeed. This decrease in range agreed with the antenna pattern results presented above. When the aircraft was placed in a 20-degree noseup attitude while inbound at a distance of 32 NM, transponder replies were received satisfactorily. The maximum range was satisfactory when the aircraft attitude was favorable.

Code Function

During mode 4 operational test, the ground station and pilot switched between IFF codes A and B. The system continued to operate satisfactorily on either code.

RELIABILITY AND MAINTAINABILITY

This section presents the results of the UH-1N R&M evaluation for the Category II test program. The period covered is from 17 October 1970 through 15 July 1971. Data were generated from the operation of aircraft S/N 68-10774 from 19 October 1970 through 15 July 1971, from aircraft S/N 68-10776 from 17 October 1970 through 15 July 1971 and from aircraft S/N 69-6610 from 26 October 1970 through 15 July 1971.

These aircraft were not tested in an operational environment; however, peculiarities of the test environment were eliminated from the data or accounted for whenever possible. R&M data were collected and analyzed using the Systems Effectiveness Data System (SEDS). A description of SEDS is presented in appendix II.

Mission Reliability

The data presented here is intended to provide numerical analysis of subsystem reliability. Reliability data were obtained by using failure information from the debriefing file; therefore, the study was based on flight crew-discovered malfunctions. As subsystem malfunctions occurred, they were classified as degraded operations or failures. A degraded operation existed when the performance of a subsystem was below normal

operating specifications, b i' ᵌs still usable. When a subsystem was rendered unusable, the malfunction was classified as a subsystem failure. There were two types of subsystem failures, no-abort and abort. No-abort failures occurred when the subsystem failed, but the failed component was not mission essential and did not cause a mission to be aborted. When a subsystem was mission essential and had a failure that caused the mission to be terminated before completion, the malfunction was classified as an abort failure. The Inflight Malfunction Review (appendix III) presents the inflight malfunctions and the associated corrective actions.

Subsystem Mission Malfunction Report.

The Subsystem Mission Malfunction Report (table XXVII) shows the flight time and the number of malfunctions that occurred on the various aircraft subsystems. Also shown is the number of missions on which each subsystem had no malfunctions. The operating time of each subsystem was taken to be the flight time on those missions when the subsystem was used. No time was credited for ground operating time or maintenance checkout time.

Two systems showed an extremely large number of malfunctions. The rotor systems and turboshaft powerplant exhibited 89 and 25 discrepancies respectively. These discrepancies generally required adjustments rather than component replacements. The replacement of a main rotor blade in two cases resulted in a large number of functional check flights (FCF's). The FCF's were required to check the effect of previous rotor tracking adjustments. Therefore, each FCF represented a previous inflight malfunction of the rotor system. The FCF's continued until correct rotor tracking was obtained. Similarly, replacement of a power section required adjustments which necessitated subsequent FCF's. Likewise, each FCF resulted in a discrepancy until satisfactory operation of the power section was obtained.

Subsystem Mission Reliability Report.

The Subsystem Mission Reliability Report (table XXVIII) shows calculated values of the mean times between malfunctions according to type. The large differences between some of the measured mean times and the associated lower confidence limits (LCL's) resulted from the low malfunction rate of some subsystems. Calculation procedures are presented in appendix IV. Based on these procedures, the UH-1N demonstrated a mean time between subsystem failures (MTBF) of 9.2 hours. There were no contractor specified or predicted reliability statistics for comparison purposes, but no significant growth in mission reliability was shown throughout the Category II program.

The trends in measured subsystem MTBF's for several work unit code (WUC) groups are shown in figures 22 and 23. The data presented in these graphs are averages for the previous 6 months, except for the first 4 months; that is, the MTBF shown for 15 December 1970 includes all data from 16 October 1970 through 15 December 1970. WUC groups not shown had an insufficient number of failures to develop any type of trend. Figure 24 presents the trend in mean time between subsystem failures for the overall UH-1N aircraft.

The following systems exhibited low inflight malfunction rates and were not major mission reliability problems: airframe, fuselage compartment, landing gear, flight controls, air conditioning, lighting system, hydraulic power supply, fuel system, miscellaneous utilities, interphone, IFF, VHF-FM, radar navigation, and weapon delivery systems.

The following systems were sources of mission reliability problems:

1. The turboshaft powerplant exhibited an MTBF of 37.6 hours. Failures of two power sections, fuel controls, and engine instruments were reliability problems.

2. The transmission system exhibited an MTBF of 97.8 hours. Blown transmission oil filter gaskets and false indications of high transmission oil temperatures were the major reliability problems.

3. The electrical power supply exhibited an MTBD of 61.1 hours. Generators dropping off the line caused the only major problem.

4. The instruments exhibited an MTBF of 163 hours. Failures of gyros, attitude indicators, and RMI amplifiers were the major problems.

5. The VHF-AM communications system exhibited an MTBF of 98.8 hours. The AN/ARC-115 Receiver-Transmitter was the high failure rate component.

6. The radio navigation equipment was generally satisfactory, except for the tacan subsystem which exhibited an MTBF of 107.0 hours and the UHF-direction finder which exhibited an MTBF of 47.2 hours. The RT-471/ARN-65 Receiver-Transmitter was the high failure rate component in the tacan subsystem. The AM-3624/ARA-50 Amplifier was the high failure rate component of the UHF-direction finder.

Efforts should be continued to improve the reliability of the systems cited above. **(R 32)**

The following systems were not used sufficiently to provide meaningful reliability statistics: high frequency communications, miscellaneous communications, emergency equipment, miscellaneous equipment, and explosive devices. These systems have not demonstrated any reliability characteristics. Using command experience will be required to define the reliability of these systems.

Hardware Reliability

An analysis of all failures (both aircrew- and groundcrew-discovered) and calculated hardware MTBF's is presented in this section. Maintenance data from the entire Category II test program was used as the basis for the reliability analysis. Failures not contained in the SEDS master history file due to inadequate documentation by maintenance personnel were identified by screening the Maintenance Discrepancy/Work Record (AFTO Form 781A) forms for each aircraft. These forms contained all writeups (both groundcrew- and aircrew-discovered) and the associated maintenance action to correct each malfunction.

Table XXIX presents hardware reliability at the major system level (first two digits of the WUC), except for the avionics systems where data is presented at the subsystem level (third digit of the WUC). Appendix V discusses failure definitions and method of MTBF calculation. The MTBF statistics are based on 489.1 airframe hours.

Maintainability

Maintenance data collected in the SEDS from 16 January 1971 through 15 July 1971 were the basis for the maintainability analysis. Maintenance data collected before 16 January 1971 were inaccurately documented and were not included for that reason. Data gathered at Eglin AFB in the Climatic Laboratory were deleted, since it was not a representative maintenance environment. Likewise, data gathered at Cold Lake, Canada, were deleted due to inadequate documentation of the rotor rigging problems which were encountered there. A numerical analysis of the maintenance manhours per flying hour (MMH/FH) based on the remainder is presented in this section.

The personnel subsystem test and evaluation (PSTE) section of this report identifies human engineering and accessibility problems which contributed to the amount of time required to maintain the UH-1N.

Maintenance Manhours per Flying Hour.

Table XXX presents the MMH/FH expended and the percent of the total MMH/FH for each WUC group. In addition, subtotals of support general, corrective MMH/FH, and total MMH/FH are shown. The MMH/FH statistics are based on 260.1 flying hours. This value for flying hours reflects the deletion of maintenance data described previously. Discussion of the method used to calculate MMH/FH values appears in appendix VI.

Support general maintenance accounted for 13.5 MMH/FH which was 72.1 percent of all maintenance performed. Ground handling, servicing, and inspections totaled 10.3 MMH/FH with preflights, postflights and periodic phase inspections accounting for 1.6, 1.7 and 3.0 MMH/FH, respectively.

The measured corrective maintenance MMH/FH total was 5.3. This was 27.9 percent of all maintenance performed. The airframe contributed 1.7 MMH/FH which resulted from cowling removals to facilitate other maintenance and time required to repair cracks which were frequently discovered during periodic phase inspections. AFFTC RUMR R70-905 (closed), detailing the excessive manhours required to remove and replace the engine cowling, was submitted.

The flight control, rotor, and powerplant systems accounted for 0.5, 0.3, and 0.8 MMH/FH, respectively. The MMH/FH for these systems basically reflected their discrepancy rates as obtained during Category II testing.

The high MMH/FH rate of the VHF communications system was caused by the addition of TCTO 1H-1UH-506 to UH-1N 610. The modification, designed to improve the operation of the VHF system, added approximately 0.4 MMH/FH not related to corrective maintenance.

All remaining systems consumed a small amount of corrective maintenance time and were not major maintainability problem areas.

Figure 25 presents the support general and total MMH/FH for data obtained from 16 January through 15 July 1971. The data presented in this graph are one-month averages; that is, the MMH/FH for 15 April includes data from 16 March through 15 April. As can be seen, no recognizable trends or growth in maintainability developed during the Category II program.

Availability

Aircraft availability is a measure of the degree to which an aircraft is in the operable and committable state at the start of the mission, when the mission is called for at an unknown (random) point in time. Inherent availability is a function of aircraft reliability, the effectiveness of maintainability design, and the adequacy of the contractor-recommended numbers of maintenance personnel, spares, AGE, and T.O.'s, but not the operational environment. Inherent availability can be expressed by the formula:

$$A_i = \frac{\text{Total Time} - \text{Active Repair Time}}{\text{Total Time}}$$

For ease of computing the active repair time the following formula was used:

$$A_i = \frac{AH/DAY - \frac{MART}{FLT}\,\frac{FLT}{DAY} + \frac{MAPT}{PI}\,\frac{PI}{FH}\,\frac{FH}{FLT}\,\frac{FLT}{DAY}}{AH/DAY}$$

where:

A_i = inherent aircraft availability

AH/DAY = active hours per day that the aircraft was available for flying and/or maintenance.

MART/FLT = mean active hours to repair the aircraft between successive flights.

MAPT/PI = mean active hours required to complete a phase inspection

PI/FH = number of phase inspections per flight hour

FH/FLT = number of flying hours per flight

FLT/DAY = number of flights per day

The MART/FLT and the MAPT/PI were calculated using only active maintenance times, since administrative and logistic delays were a function of the maintenance management at each operational unit and therefore must be excluded from any calculation on inherent availability. Also excluded were times for any support general maintenance. Figure 26 presents results obtained from Category II testing from 16 January 1971 through 15 July 1971 on aircraft 774, 776, and 610. The Category II A_i calculations were broken down as:

MART/FLT = 1.83 active hours per flight

MAPT/PI = 21.1 active hours per phase inspection

PI/FH = 0.04 phase inspections per flying hour (a constant)

FH/FLT = 1.5 flying hours per flight (arbitrarily chosen as a typical flight length)

FLT/DAY = 1, 2, or 3 flights per day (calculations were made for each case)

AH/DAY = 8, 16, or 24 hours per day (calculations were made for each case)

Comparison of actual operational results with the Category II achieved results will assist an operational unit in determining both inherent aircraft availability, and also what must be improved to achieve the desired availability. The major factors that significantly affect inherent availability are MART/FLT, MAPT/PI, and AH/DAY.

For example, if an operational unit determined that the availability must be increased, they may need to decrease MAPT/PI and MART/FLT by increasing manning, or increasing the length of the workday (AH/DAY).

PERSONNEL SUBSYSTEM TEST AND EVALUATION

During the UH-1N Category II test, a limited Personnel Subsystems Test and Evaluation (PSTE) was conducted. Primary emphasis was placed on the following specific goals under AFR 80-46:

".... to determine:

1. If human engineering requirements and criteria have been incorporated into the system design and are adequate;

2. If biomedical and safety criteria have been met;

3. If the system provides for efficient human performance in its intended operational environment."

The effort was guided by the PSTE test plan, appendix A-5 of reference 3. The main criteria applied in evaluating PSTE findings were the aircraft detailed specification (reference 27), standard human engineering practice as contained in military standards and handbooks, references 28 through 31; and in addition, the known and forseable mission requirements. Equipment which had been evaluated in other programs was not retested unless the UH-1N application was significantly different in its environment, mission, or task load.

Airframe

The cowling surrounding the aircraft engines opened to provide convenient and ready access to most powerplant components. During engine

changes, however, the difficulty experienced in removal and replacement of the baffles and cowling caused significant maintenance delays. Although precise task times were not obtained, the maintenance manhours required to deal with cowling and baffles during engine changes were in excess of 40 for each change performed during the Category II test. This was approximately 10 times the comparable figure for other aircraft of this type. Future versions of the UH-1N should incorporate cowling which can be removed easily and quickly for engine changes. **(R 33)**

One particular baffle fastener had extremely limited access and was more troublesome than the others. It was located on the middle firewall installation and secured the upper half to the lower half adjacent to the main power quill chamber. The fastener can be identified in figure 46 of reference 32. In aircraft 610, a Philips head screw and nut plate were oriented with the screw pointing upward; access to the screwhead was blocked by the engine which was 1/4 inch away. This arrangement should be reversed so that the nut plate is on the opposite half of the baffle and the screw is pointing downward. **(R 34)**

On the engine cowling installation a louvered door was provided in the aft lower section of each power section to gain access to the fire extinguisher installations. These doors, P/N 212-061-812-101 and 102, figure 25 of reference 32, flexed excessively under the pressure required to operate their securing latches. The door generally appeared weak, and the hinge assembly was worn and loosened. The doors should be redesigned to strengthen the door structure. **(R 35)**

Three stress panels were located on the sides and center of the center bulkhead assembly enclosing the transmission, hoist and other components. On aircraft 610 these panels were marked to indicate they were load bearing panels required for ground run or flight operations. The labels to this effect were on the panels but not on any nearby bulkheads, padding or other structures. Consequently, when the panel was removed the label was also removed. Due to the cautionary nature of the message, it should be posted on adjacent nonremovable locations to prevent possible operation of the aircraft with the stress panels removed. There may have been several other such stress panels in this and other locations which were not observed because they were not removed. When installed, they were normally covered with padding which covered the message. The entire aircraft should be surveyed for stress panels with this marking discrepancy. Wherever found, appropriate cautionary labels should be applied to nearby structures which remain visible and in place when the stress panel has been removed. **(R 39)**

On the right side of the forward fuselage a small door was installed to cover the ground power receptacle used during electrical tests and for most engine starts. The door was secured by a slotted pan head "DZUS NUT." As a convenience to ground operators this nut should be changed to a DZUS type wing nut so that a screwdriver is not required. The wing nut head should be aligned with the airstream in the latched position. **(R 40)**

Inside the nose avionics compartment there was a receptacle for a grounding cable plug near the main battery connector. To use this ground point, the cover of the compartment had to be opened. In order to close

the cover with the ground wire attached, the wire had to be threaded through one of the openings of the securing latches. This ground point should be directly accessible from the outside because it is often desirable to ground the aircraft before touching it. This would also save time and prevent unnecessary wear on the avionics door assembly. The ground receptacle should be moved to a nearby external location or another receptacle should be added in such a location. **(R 41)**

The right-hand fuselage post installation included two steps covered by spring loaded doors. The steps were used as a ladder to gain access to the top of the aircraft. Two air ducts were routed vertically inside the post assembly. They were located just forward of the foot steps. In both aircraft 610 and 774 these ducts were damaged by workers' feet. All showed abrasion damage, and in several locations the air duct had been perforated. To prevent this the air ducts should be guarded by a sheet metal baffle. **(R 42)**

The aft portion of the fuselage of UH-1N 610 had a waist-level door (reference 32, figure 161, item 49/57; part number uncertain) which opened on a bay while also giving access to the lower side portion of the aft fuselage. This open space was an inviting location in which to stow packages or other cargo. Forward of this location and just aft of the cargo door there were two other access doors which opened on equipment bays (reference 32, figures 162 and 163; P/N 250-030-028-3 and -33, and 250-030-029-3 and -031-3). Those spaces were also inviting locations in which to stow cargo. Placard regulating the use of these compartments for baggage or other cargo should be applied. **(R 36)**

The two doors nearest the cargo door were secured and latched with fittings used in several other locations on the aircraft (P/N H605S063A123). In this application the four latches, two for each door, aligned vertically. If any one of them were left in the opened condition serious interference could occur between the latch and the cargo door. The rear edge of the main cargo door could pass over an open latch; then the door could not be closed. This condition required unmounting the cargo door. Several latches were damaged on aircraft 610 and 774 (figure 29). The fasteners in this location should be changed to another type found in several locations on the aircraft such as P/N 90-005-5 or -1. **(R 37)**

On the lower aft portion of the engine cowling three small spring-loaded doors were installed to serve as visual access to the transmission and combining gearbox oil sight gauges. One door was located on the right lower aft cowling and two doors were in a larger swing-away door in the forward lower cowling section, one on each side. In all three cases the doors were unusable because interference with installations behind them prevented full opening and viewing. To check the sight gauges other larger doors in the area must be opened. Designs of this nature should be avoided on future helicopter designs. **(R 38)**

During climatic testing at the Eglin AFB climatic hangar, and again during the Category II test at AFFTC, the cockpit window above the pilot's seat was broken. In both cases the damage resulted from maintenance personnel inadvertently kicking or stepping on the window. The windows were exposed to this type of damage during maintenance on the upper work surfaces due to their location and lack of protection. Rigid covers should be provided and installed during lengthy periods of maintenance when personnel are using the upper work surface. **(R 43)**

The configuration of the fuselage post ladder also contributed to the likelihood of this type of damage. Figures 30 through 33 illustrate the normal or "natural" method of using the ladder. Since the first step was several inches to the left of the others, the natural response was to climb the ladder using the left foot first. This sequence ended on the right foot; a slip or error could result in damage to the window. The correct method, as seen in figures 34 through 37, required an awkward sequence of climbing using the right foot first, and crossing the left foot over the right while climbing, to end the sequence on the left foot. To prevent damage while using the ladder, the first step should be moved forward to a position beneath or to the right of the other step locations. **(R 44)**

Cockpit

The auxiliary door latch handles were located on the inside of the cockpit doors near the forward edge. They were provided because the regular door handles were inaccessible with either seat armor in place or with the seats in a forward position. The small lever was 2.75 inches long and about 0.5 inches thick. Actuation forces at the tip of the lever were 27.5 pounds to engage the door latch and 38 pounds to disengage the latch. These forces made operation of the door latch very difficult and inconvenient. The handle itself was small and awkward to use, and the forces required exceeded those allowed in table B 4.3 of AFSCM 80-3. Since the primary door latch handles were inaccessible (for the conditions mentioned above) these auxiliary handles were the actual main handles for operation of the doors from inside. For both normal and emergency operations they should be easy and convenient to use. The auxiliary door latch levers should be altered or redesigned to reduce the forces required for their operation. **(R 45)**

Cargo Area

In the cargo compartment there were no grip points or other hand holds installed in the overhead areas. Movement of personnel was seriously impeded during maintenance and inflight operations both with and without the main seat installations. The installation of several sturdy hand grips would make movement inside the cargo area safe and more convenient. Several functionally located hand grips should be installed in the cargo area. **(R 46)**

Weapons

The 7.62mm minigun installation included a warning light in the operator's right hand grip. When illuminated, the light indicated that the weapon was armed and activated, ready for firing. One of the Category II weapons had a failed light. It could not be determined in advance whether or not the weapon was ready to fire. This resulted in several dry run passes over intended targets because one of the preparatory steps had been overlooked or incorrectly performed. It also made it necessary to actually fire the weapon in order to determine if it was ready to be fired. On the first occasion after the light failed, personnel were unaware that the weapon was "hot" because the light had no redendant or self-test features. In reference 33, Design Note 3M5 concerning visual warning indicators recommends, in part, "Provide two bulbs or filaments so that one of them remains lighted when the other fails." This system

should be changed so that the status of the weapon is always indicated correctly. Other suitable solutions include an additional warning light in the pilot panel warning light group or a press-to-test feature added to the present warning lamp. (R 47)

On one grenade launcher mission an error occurred in loading the ammunition cans, feed belt, and launcher. Rounds were loaded with the male link end leading into the laucnher first. This caused the link to be broken which jammed the launcher mechanism and required disassembly of the launcher. It was clear that damage to the launcher could have occurred, and it appeared that this error could have caused explosion of unchambered rounds producing serious injury to personnel and damage to the aircraft. An AFTO Form 22 was submitted requesting changes to the Technical Order loading procedure and illustrating diagram (reference 34). Part of the change requested called for clarification of figure 3.2, page 3.2. This drawing was identical to the loading diagram decal on the 40mm ammunition can. Consequently, the decal should be changed to correspond with the anticipated change in the T.O. drawing. The AFTO Form 22 recommended "Figure 3.2 should be redrawn so that rounds pictured in inset A align with rounds at arrow A. The link direction should be clearly depicted. Arrows labeled 'A' and 'B' should be inserted in insets A and B to correspond exactly with arrows A and B in the larger diagram." This is the minimum change that should be made. A more adequate change would be to completely revise the ammunition can decal to improve it generally and to clearly depict all important features of the loading procedure. The new drawing should show the position of the links as loading of the can begins, the link direction as rounds exit the can cover and link direction in the feed belt. The decal should include a warning stating that the female link end must feed first into the launcher or jamming, gun damage, and personnel injury may result. (R 48)

Maintenance Problems and Miscellaneous

Maintenance personnel observed mislabeled hydraulic lines on UH-1N 610. The lines in the tail section running to the tail rotor pitch control were labeled SYS 2. These should be labeled SYS 1. Existing aircraft should be checked for proper labeling; the labels should be corrected if necessary, and the contractor should insure that new aircraft are labeled correctly. (R 49)

Labels and markings on the exterior of the aircraft (both 610 and 774) were seriously deteriorated on the bottom of the fuselage. There were over 50 separate labels or markings in the area starting at the lower edge of the cockpit and cargo doors. The combined action of oils, hydraulic fluid, and the airstream detached and disintegrated some or most of each label. The markings were satisfactory on other portions of the aircraft and remained legible and attached, however, on the lower fuselage it appeared that the adhesive employed had softened, allowing the labels to detach and break up. The adhesive should be improved to withstand the oil conditions or the labels should be overcoated with a resistant material. (R 50)

In performing maintenance on the rotor assembly, small parts were dropped by maintenance personnel. These often fell into the transmission opening. Much time was expended retrieving screws, washers, safety wire, etc., from the transmission well. To save time and reduce flight hazards

due to jamming of such items in the numerous control system components a canvas cover should be used to shroud the opening during rotor maintenance. (R 51)

Kit 7A050 was used in balancing the rotor hub. It was assembled and leveled before use. There were no adjustments in the legs of the tripod stand on which it was mounted to assist in leveling (one of the legs was formed by the box in which the kit was stored). To make the leveling process faster and more convenient threaded adjustments should be added to the legs of this kit. (R 52)

Alignment of the rotor and hub assembly with the rotor shaft during reassembly was awkward, and in one case observed, required almost one manhour to accomplish. It appeared that a fixture to serve as a pilot shaft in guiding the rotor hub into alignment with the rotor shaft would have been an effective time saver. The need for a pilot shaft fixture should be determined by further observation and evaluation of the rotor change procedure. (R 53)

Aircraft Noise Levels:

Tables XXXII and XXXIII show the results of internal and external noise surveys using a General Radio Model 1558A Octave Band Analyzer. All values here and in other sections are decibels referenced to 0.0002 dynes per square centimeter. Differences in the overall and low frequency noise levels between test dates were probably due to changes in very low frequency (less than 20 Hz) rotor noises. The very high OVERALL and LOW PASS TO 75 Hz values observed in the 22 July 1971 tests did not reflect noise in audible frequencies of concern.

Figure 38 illustrates overall noise levels in the area surrounding the aircraft during low level hover operations. The measurements were made with a General Radio Model 1551C overall noise level meter using the A-weighted scale. The results reflect the sound environment to which ground personnel are exposed during approach, departure, and hover conditions such as hoist operations.

Figures 39 and 40 were prepared from the data in table XXXII to illustrate the internal noise levels compared with those in reference 27. Although internal noise levels exceeded those specified, the condition was not significant with respect to aircraft mission requirements and was not considered serious enough to warrant attempts to reduce noise levels in the aircraft. Noise levels in the 75 to 9,600 Hz frequency bands indicated that for all operations ground and flight crews should use hearing protectors in the form of sound suppressing flight helmets, earplugs, or ear muffs. The noise environment of the UH-1N was generally comparable to that of other aircraft and standard hearing conservation practices currently in use provided adequate personnel protection. (R 54)

Internal noise levels during grenade launcher operations created serious hearing loss hazards. Noise levels throughout the aircraft exceeded 150 decibels during grenade launcher operation. Appropriate impulsive sound level test equipment could not be obtained to make accurate measurements of these noise levels. From the data available, however, serious doubt existed as to whether any form of available hearing protection could prevent hearing losses in crewmembers exposed to

grenade launcher noises. For grenade launcher operations exposure should be limited to mission essential personnel, and those who are exposed should employ the best available hearing protection. Modifications to the grenade launcher should be made, if possible, to reduce the noise levels at the source. (R 55, R 56)

Practical suggestions for improved hearing protection include the use of special sound supression helmets (such as the Gentex SPH4); the use of extra padding behind earphone cups in the standard helmet (personnel equipment shops can install this); and the use of type V51R earplugs with the standard helmet.

Loudhailer

The loudhailer was installed and tested using a 1,000-Hz tone at various power settings to determine noise levels inside the aircraft and to establish the radiation pattern of the speaker around the aircraft. Sound level measurements were obtained with a General Radio Model 1551C overall/sound level meter using the unweighted scale (flat response to 20,000 Hz). Table XXXIV indicates noise levels in the aircraft during 1,000-Hz tone operation in level cruising flight. Power was established at a 0 reading on the output level VU meter of the loudhailer.

With the aircraft on the ground, measurements were made at 100 percent rotor rpm, directly in front of the speaker itself, but the range of the test equipment did not permit operation at full power. At a VU meter level of -9 the 1,000-Hz tone signal level was 134 decibels; to obtain 145 decibels signal level, the practical limit of the test equipment, a power setting of -3 on the VU meter was required. The background noise level due to helicopter operation was 115 decibels.

Figure 41 illustrates the relative power radiation pattern. The measurements were made at ground idle with a background noise level near the speaker of 115 decibels. The power setting employed was that required to produce 135 decibel signal and noise at the speaker. The sound radiation pattern close to the aircraft was most intense in the forward diagonal quadrant; however, at 100 feet no differences were observed. Inflight measurements of this type were not performed.

These results indicate that the loudspeaker system required added care and attention to hearing protection to prevent hearing losses. Because of the high internal sound levels, the speaker should not be operated in the retracted position. Exposure to these sound levels should be limited to mission essential personnel and those who are exposed should employ the best available hearing protection. (R 55, R 57)

Special emphasis should be placed on hearing conservation practices during ground maintenance and checkout operations of the loudhailer. (R 58)

CONCLUSIONS AND RECOMMENDATIONS

The UH-1N airframe, fuselage compartment, flight controls, and electrical system were generally acceptable. The cargo suspension unit and rescue hoist performed satisfactorily. The loudspeaker system kit proved to be largely ineffective. Early VHF-AM and UHF communications deficiencies were effectively corrected by a TCTO. The AN/ARC-102 receiver-transmitter became inoperative and testing could not be completed. Most other avionics equipment proved satisfactory, although specifications often were not satisfied. A reliability study determined that several systems on the aircraft required reliability improvement. The airframe exhibited high noise in flight and certain design features caused difficulty or hazard to personnel.

1. Those recommendations covered in UMR's and made previously in the AFPE report (reference 10) which are still "open" should be implemented (pages 1 and 2).

AIRFRAME

The airframe was considered satisfactory for operational use. Ground handling wheels interfered with LAU-59 rocket launch system, and ground handling with the wheels was slow and tedious, requiring manual assistance. Reversal of wheels eliminated interference with the LAU-59 system.

2. T.O. 1H-1(U)N-2-1 (reference 13) should be supplemented to allow reversed-position installation of the ground handling wheels to provide rocket launcher clearance (page 3).

3. The ground handling system should be improved to facilitate more rapid aircraft movement (page 3).

Seat armor caused considerable difficulty in crew egress and aircraft operation.

4. Seat armor should be modified to reduce interference with aircrew activities (page 4).

The proximity of hydraulic components in the transmission compartment would preclude system redundancy in event of battle damage. Tail rotor pitch controls were a source of maintenance problems and UMR's were written.

5. Armor plate protection of hydraulic boost components in the transmission compartment should be incorporated (page 5).

Operation of the aircraft electrical system was found satisfactory under all flight loads. Switching and overload protection provisions were adequate. A generator balance circuit wiring error caused balancing adjustment difficulty, but did not preclude proper operation. The generator warning light system was found ambiguous under certain conditions.

6. T.O. procedures for generator balancing should be changed to specify that balancing controls be turned toward minimum resistance instead of specifying direction of adjustment rotation (page 6).

7. The generator warning system should be changed to cause warning illumination any time a particular generator is not providing power (page 6).

The BL-8300 rescue hoist functioned satisfactorily. It was found that the forest penetrator could release itself from the hook. Cable guillotine current was supplied by the non-essential dc bus. Temporary loss of power on this bus might cause delay in cable jettison. Lights associated with the system could not be dimmed.

8. A positive means of locking the hook closure should be incorporated in the hoist (page 7).

9. The cable-cutting guillotine wiring should be changed so that the squib is fired by the dc essential bus (page 7).

10. Hoist indicator lights should have provisions for dimming (page 8).

11. Flight Manual information for the hoist duty cycle should be expanded (page 8).

The SA-1800C loudspeaker system was of very limited usefulness due to the high level of UH-1N flight noise. Lack of quality control was a serious problem with this unit. Feedback was a limiting factor in use of the handheld microphone. Area coverage with the system was small. Speech could be understood up to a radius of 0.5 miles and 500 feet altitude off the left side of the aircraft. High pitched, slow speech was most easily understood. Surface wind severely hindered listener hearing ability.

12. SA-1800C systems already manufactured should undergo inspection and bench test before use (page 9).

13. Future manufacture of the SA-1800C should include quality control and functional checks (page 9).

14. An enclosed anti-feedback microphone should be provided (page 10).

Operation of the cargo hook system was satisfactory.

COMMUNICATION EQUIPMENT

Frequency changes with all R-T units required pilot time and effort which could jeopardize flight safety during periods of high workload such as IFR approach.

15. UHF and VHF radios should have preselect channel capability including radio guard-transmit capability (page 11).

Pre-ECP ground tests showed that the ARC-115 did not meet power output specifications. The pre-ECP ARC-116 power tests met specifications but there was excessive power loss (VSWR) in the UHF antenna wiring. Both systems demonstrated inadequate range, deficient antenna patterns and poor communications reliability. Tests following the ECP antenna changes demonstrated considerable improvement in these areas. Although maximum range could not be demonstrated due to terrain limitations, post-ECP performance of both sets was satisfactory.

The ARC-114 system met power, VSWR, range and antenna pattern specifications. The Flight Manual did not adequately define VHF-FM homing procedures. The ID-347/ARN display of homing signal strength was found inadequate.

16. The Flight Manual should be revised to clearly define the operation of the VHF-FM homing function (page 17).

17. The sensitivity of the signal strength indicator should be increased and the presentation should be changed to provide a centered-needle indication when over target transmitter (page 18).

Tests on the AN/ARC-102 were very limited due to failure of the antenna coupler CU 1658/A. HF radio (AN/ARC-102 antenna kit (HF longwire) was designed to be used on the "D" model instead of the "N" model, and it did not allow the left cargo door to open fully without coming in physical contact with the antenna.

18. The AN/ARC-102 should be designed so as to avoid contact with the aircraft cargo door (page 18).

19. Further testing of the AN/ARC-102 should be performed (page 18).

During gunfiring it was impossible to use the C-6533 intercom between the pilot and gunner due to the high gun noise level. Operation was otherwise adequate.

20. Further testing should be accomplished in an attempt to find a better helmet and microphone for the gunner (page 19).

NAVIGATION EQUIPMENT

The accuracy of the gyromagnetic compass system installed on aircraft 774 was acceptable. The accuracy of the compass system on aircraft 610 was unacceptable, however the compass had not been recompensated after installation of several other avionics systems. The deviations observed were within the normal range of the compensating adjustments. The drift rate when operating in the directional gyro mode was satisfactory.

In its present location the AQU-5A magnetic compass required recompensation when the XM60 sight was installed or removed. It was not located within the view of both pilots.

21. The technical manual (reference 13) should contain an instruction to compensate the AQU-5A Magnetic Compass whenever the XM60 sight is installed or removed (page 21).

22. The AQU-5A Magnetic Compass should be relocated to a better location (page 21).

The bearing accuracy of the UHF-DF system installed in the test aircraft did not meet specified accuracy requirement of ±7 degrees RMS value. The homing capability was satisfactory even though the aircraft did not follow a straight line path in reaching the ground station.

23. Additional testing should be conducted to determine the reason for the bearing accuracy deviations. The system should then be modified to eliminate this problem (page 22).

The tests performed with the tacan system demonstrated that the radial and distance accuracy specifications were not met; however, the small deviations did not significantly affect the operational capabilities of the tacan system. No significant antenna-related system inaccuracy was observed. During maximum range test, the operational range exceeded 80 percent of maximum radio path distance on all test points. The tacan system was satisfactory for the UH-1N mission.

The AN/ARN-89 ADF system did not meet the specified accuracy requirements of ±5 degrees of the actual bearing to the transmitter. However, the ADF homing was satisfactory. The accuracy of the navigation fixes was acceptable for airways navigation. Available compensation settings were not adequate; however, errors observed indicated that the system could be compensated if accurate compensation data were available.

24. Additional testing should be conducted to determine proper compensation settings for the ADF system (page 25).

The VOR bearing information presented on the BDHI was not acceptable due to oscillation of the pointer. The ILS function of the VOR receiver performed satisfactorily. The VOR antenna pattern and reception range were adequate. The VOR receiver was marginally acceptable for the UH-1N mission.

25. The oscillation in the BDHI display of the VOR receiver should be investigated to determine its source and the effect on receiver accuracy; the VOR installation should be modified to reduce the oscillation to an acceptable level (page 26).

The radar altimeter system was operationally satisfactory and met specified accuracy requirements. It is possible that the system may lock onto large external cargo loads.

26. A NOTE should be placed in the Flight Manual stating the possibility that the radar altimeter may lock up on a sling load rather than the terrain (page 29).

The R-1041( )ARN Marker Beacon Receiver was operationally satisfactory for ILS procedures. The deviations observed in antenna pattern

symmetry ratios were not significant. At high altitudes, the receiver may not respond to beacon signals when sensitivity is set on LOW.

27. The Flight Manual should state that the HIGH-OFF-LOW switch should always be placed in the HIGH position unless operating below 1,000 feet AGL (page 30).

APX-72 range and mode functions operated satisfactorily. The AAU-21 Altimeter Encoder was poorly located. Wiring provisions for its installation were on the copilot instrument panel. The aircraft wiring provided only 28 vdc power for the Mark XII computer.

28. Wiring should be re-routed to permit location of the AAU-21 Altimeter Encoder on the pilot instrument panel (page 31).

29. The aircraft should be modified to provide 115-volt, 400-Hz ac power to the Mark XII computer (page 31).

The wiring harness to connector P916 was too short and accessibility to the RT-859/APX-72 Receiver-Transmitter and Mark XII computer was poor.

30. The RT-859/APX-72 and Mark XII computer should be relocated to a more accessible location in the forward electronics compartment (page 31).

Due to fuselage masking, the single antenna installed on the lower surface of the aircraft fuselage did not allow adequate forward coverage.

31. A top-front mounted antenna and an antenna switching unit should be installed to correct the forward antenna pattern null (page 32).

IFF code hold/zero function, mode C altitude correction, maximum range, and mode 4 IFF code were satisfactory.

RELIABILITY AND MAINTAINABILITY

No significant growth in mission reliability or maintainability was shown throughout the Category II program. Mission reliability problems were experienced in the following systems: turboshaft powerplant, transmission, electrical power, instruments, VHF-AM communications, tacan, and UHF-direction finder.

32. Efforts should be continued to improve the reliability of the systems cited above (page 35).

The following systems did not present mission reliability problems: airframe, fuselage compartment, landing gear, flight controls, air conditioning, lighting, hydraulic power supply, fuel system, miscellaneous utilities, interphone, IFF, VHF-FM communications, radar navigation, and weapon delivery system. Using command experience will be required to further define the reliability characteristics of the following systems: high frequency communications, miscellaneous communications, emergency equipment, miscellaneous equipment, and explosive devices.

Removal of the cowlings and baffles for engine change was difficult and time consuming.

33. Future versions of the UH-1N should incorporate cowlings which can be removed quickly and easily (page 39).

Access to one particular engine firewall baffle fastener described in the text was extremely limited.

34. Access should be improved by reversing the fastener so that the nut plate is on the opposite half of the baffle and the screw points downward (page 39).

A lowere door on the engine cowling appeared weak, flexed under pressure, and had worn hinges.

35. The doors should be redesigned to strengthen the door structure and hinge assembly (page 39).

Ca 10 and baggage could be stowed in several compartments behind the aft uselage doors.

36. Placards regulating the use of these compartments for baggage or other cargo should be applied (page 40).

Fasteners on the aft fuselage doors could jam the main cargo door.

37. The fasteners should be changed to another type found in several locations on the aircraft such as P/N 90-005-5 or -1 (page 40).

Three visual access doors were unusable because of interference with structures behind them.

38. Errors of this nature should be avoided on future helicopter designs (page 40).

Placards were applied to several stress panels to indicate that the panel was required for ground or flight operation. When the panel was removed the message was removed with it.

39. The entire aircraft should be surveyed for stress panels with this marking discrepancy. Appropriate cautionary labels should be applied to nearby structures which remain visible and in place when the stress panel has been removed (page 39).

A slotted head DZUS nut was installed on the ground power receptacle door.

40. As a convenience to ground operators, s nut should be changed to a DZUS type wing nut so that a screw river is not required. The wing nut head should be aligned with the airstream in the latched position (page 39).

The forward ground receptacle was underneath the avionics compartment door.

41. The ground receptacle should be moved to a nearby external location or another receptacle should be added in such a location (page 40).

Air ducts inside the fuselage post ladder doors were footworn.

42. To prevent this, the air ducts should be guarded by a sheet metal baffle (page 40).

Due to its location and lack of protection the cockpit ceiling window was exposed to damage when the upper work surfaces were in use and when the post ladder was used.

43. To reduce the likelihood of ceiling window breakage, rigid covers should be provided and installed when long period of maintenance are performed on the upper work surface (page 40).

44. To prevent damage while using the ladder, the first step should be moved forward to a position beneath or to the right of the other foot step locations (page 41).

The cockpit door auxiliary latch handles were small and required 27 to 38 pounds of force to actuate the latch.

45. The auxiliary door latch levers should be altered or redesigned to reduce the forces required for their operation (page 41).

Movement in the cargo compartment was difficult because there was nothing to hang on to.

46. Several functionally located hand grips should be installed in the cargo area (page 41).

The ready-to-fire warning light in the 7.62mm minigun failed leaving its status uncertain.

47. The system should be changed so that the status of the weapon is always indicated correctly. (Reference 33 requires redundant bulbs or filaments) (page 42).

The grenade launcher loading diagram contained in reference 34 was reproduced on the 40mm ammunition cans. Its lack of clarity contributed to a loading error. An AFTO Form 22 was submitted requesting changes to the diagram in reference 34.

48. The ammunition can decal should be changed to correspond with changes indicated in the text of this report (page 42).

Tail section hydraulic lines were mislabeled on aircraft 610.

49. Existing aircraft should be checked for proper labeling. The labels should be corrected if necessary, and the contractor should insure that new aircraft are labeled correctly (page 42).

Labels on the oily bottom surface of the aircraft were seriously deteriorated.

50. The adhesive should be improved to withstand the oily conditions or the labels should be overcoated with a resistant material (page 42).

Small parts dropped during rotor maintenance caused delays while they were retrieved.

51. A canvas cover should be used to shroud the opening during rotor maintenance (page 43).

The rotor hub balancing kit required leveling before use but had no adjustments.

52. To make the leveling process faster and more convenient, threaded adjustments should be added to the legs of this kit (page 43).

It appeared that a pilot shaft to align the rotor hub with the rotor shaft would be a time saver.

53. The need for a pilot shaft fixture should be determined by further evaluation of the rotor change procedure (page 43).

Noise levels in the aircraft were high, particularly during operation of the XM-94 Grenade Launcher and the loudspeaker systems. Such noise levels may cause hearing damage to personnel.

54. For all operations, ground and flight crews should use hearing protectors in the form of sound suppressing flight helmets, earplugs, or earmuffs (page 43).

55. For grenade launcher and loudhailer operations, exposure should be limited to mission essential personnel and those exposed should employ the best available ear protection (page 44).

56. Modifications to the grenade launcher should be made, if possible, to reduce noise levels at the source (page 44).

57. Because of the high internal sound levels, the loudspeaker system should not be operated in the retracted position (page 44).

58. Special emphasis should be placed on hearing conservation practices during ground maintenance and checkout operations of the loudhailer (page 44).

APPENDIX I
UMR SUMMARY

UMR No.	Date	Deficiency	Status
71-257	30 Apr 70	Flight controls: failed bearing in tail rotor control linkage.	Open
70-46	5 Dec 70	Binding rudder pedal system.	Closed
70-904	8 Dec 70	Airframe: engine inlet duct broken.	Closed
70-906	8 Dec 70	Airframe: broken latch on fairing assembly.	Open
71-254	22 Feb 71	Tail rotor drive shaft hanger bearings lost lubricant.	Closed
71-79	22 Feb 71	Flight controls: failed bearing in tail rotor control linkage.	Open
71-258	29 Apr 71	Tail rotor servo pitch bracket: bushings worn.	Open
71-326	10 May 71	AN/APX-72 wiring harness too short.	Closed
71-336	1 Jun 71	Tail rotor pitch control tube abrasion.	Open
71-252	30 Jun 71	Flight controls: failed bearing in tail rotor control linkage.	Open
71-[illegible]99	6 Aug 71	SA-1800C loudspeaker system: wiring errors.	Open

APPENDIX II
SYSTEMS EFFECTIVENESS DATA SYSTEM

The SEDS was used for the collection, storage, retrieval, and analysis of the data for this evaluation.

AFSC FORM 258/258-4 MAINTENANCE DATA

Data Collection Form:

The first source used for data input to SEDS was the Maintenance Discrepancy/Production Credit Record, AFSC Form 258/258-4 (figure 27). This form is essentially hardware-oriented.

Data Collection Procedures:

The AFSC Form 258/258-4 was filled out according to AFSC Maintenance Technical Directive 69-1 (reference 35). It was completed by the maintenance technicians to document every maintenance action on the aircraft. The AFSC Form 258 was used to document such actions as fix-in-place repairs and support-general maintenance. The AFSC Form 258-4 was used to document removal of repairable parts which underwent further processing. The completion and initial editing of the 258 Forms was the responsibility of the UH-1N maintenance organization. After the forms were completed they were keypunched, edited, and used to update the SEDS maintenance history file regularly.

AFFTC Form 0-294 Mission Debriefing Data:

Data Collection Form.

The second source used for data input to SEDS was the Aircraft Debriefing Record, AFFTC Form 0-294 (figure 28). This form is oriented toward subsystem mission performance.

Data Collection Procedures.

The AFFTC Form 0-294 was used to record the flight crew's analysis of a mission and to report system malfunctions which occurred during a mission. Information on the form included aircraft serial number, mission number, date of mission, duration of flight, mission effectiveness, and codes which reflected the reliability of subsystems used during a mission. Codes used to record subsystem reliability were:

Code	Meaning
No Entry	Subsystem not used.
1	Subsystem operated satisfactorily.
2	Subsystem had a malfunction, but could be operated in a degraded state.
3	Subsystem failed, was inoperable or unusable, but did not cause a mission abort.
4	Subsystem failed and caused a mission abort.
5	Subsystem was flown with a known discrepancy.

If more than one malfunction was noted on a single subsystem, the reliability code of the most serious malfunction was used. The form was also used to record a brief narrative of the individual discrepancies and sufficient information to correlate the malfunction with the AFSC Forms 258/258-4 which were used to document troubleshooting and repair.

Accurate completion of the form was the responsibility of the flight crew and the reliability engineer. The forms were reviewed by the reliability engineer and then keypunched into card form to update the debriefing file of the SEDS data base.

SEDS Data Base:

The SEDS data base was structured in the following manner. Each AFSC Form 258 maintenance report constituted a line item record in the maintenance part of the data base. Similarly, each AFFTC Form 0-294 mission debriefing report constituted a line item record in the operational part of the data base. Even though all maintenance actions were documented on the AFSC Forms 258, this did not mean that all the maintenance to repair a particular malfunction was recorded on a single form. In some cases, more than one form was necessary to document all maintenance actions to clear a malfunction. A maintenance event was defined as all related maintenance actions required to clear a discrepancy.

The data collected from the AFSC Forms 258/258-4 and AFFTC Forms 0-294 constituted the SEDS data base from which all data products contained in this report were derived. The basic philosophy of SEDS was to portray as realistically as possible the exhibited reliability and maintainability of the UH-1N. The effects of maintenance management, supply, and research and development functions were eliminated whenever possible.

APPENDIX III
INFLIGHT MALFUNCTION REVIEW

System	Number	Severity	Flight Squawk	Corrective Action	Part Number
Airframe	1	Ground abort.	Right door pins wouldn't fully engage.	Door jettison pin repaired.	204-030-790-11
Airframe	1	Failure.	Pilot's emergency release not operable.	Repaired door jettison pin.	204-030-799-11
Airframe	1	Degraded operation.	Right-hand cargo door difficult to open.	Door latches trimmed and adjusted.	205-031-435-1
Flight Controls	1	Degraded operation.	Cyclic force trim system sticking.	Remove/replace cyclic diodes.	30-037-1
Flight Controls	1	Degraded operation.	Pilot's No. 1 throttle had more movement than copilot's	Rerigged No. 1 throttle.	212-001-164-1
Flight Controls	1	Degraded operation.	Rudder forces too light with force trim on.	Force gradient springs adjusted.	204-001-045-9
Flight Controls	1	Degraded operation.	Boost-off forces still high.	Rechecked collective rigging.	212-076-005-7
Flight Controls	1	Failure.	Tail rotor control pedals binding.	Removed/replaced lever assembly.	209-011-712-1
Flight Controls	1	Air abort.	Binding in tail rotor controls.	Removed/replaced lever assembly.	209-011-712-1
Rotor Systems	9	Degraded operation.	Autorotation rpm too high or low.	Adjusted pitch change link.	204-011-137-1.
Rotor Systems	1	Ground abort.	Main rotor out of track.	Tracked and adjusted main rotor blades.	- - -
Rotor Systems	1	Degraded operation.	1-1 vertical vibration above 75 KIAS.	Removed/replaced white blade.	204-012-001-19
Rotor Systems	77	Degraded operation.	Vertical vibration unacceptable.	Adjusted rotor tracking.	- - -
Rotor Systems	11	Degraded operation.	Boost-off collective forces excessive.	Adjusted TT straps.	2601399
Turboshaft Powerplant	1	Degraded operation.	ITT fluctuating.	Corrected when engine replaced (not for maintenance).	- - -
Turboshaft Powerplant	1	Degraded operation.	No. 2 engine ITT fluctuated ±20 deg.	Removed/replaced ITT indicator.	MS24569-1
Turboshaft Powerplant	1	Ground abort.	N_g, torque, and ITT oscillate after activation of beep actuator.	Engine controls, droop compensator controls, and rigging checked.	- - -
Turboshaft Powerplant	2	Degraded operation.	No. 2 engine ITT fluctuated.	Tightened loose thermocouple wire.	- - -
Turboshaft Powerplant	1	Degraded operation.	No. 2 engine flight idle did not hold adjustment.	Removed/replaced automatic fuel control.	3017220
Turboshaft Powerplant	5	Degraded operation.	Engine low in torque at topping.	Adjusted automatic fuel control.	3018400-1
Turboshaft Powerplant	1	Ground abort.	Leak in manual fuel control interconnecting tube.	Removed/replaced manual fuel control.	3014976
Turboshaft Powerplant	1	Failure.	No. 1 engine fuel flow indicator failed.	Removed/replaced manual fuel control.	3014976
Turboshaft Powerplant		Degraded operation.	Combining gearbox oil filters leaking at mating points.	Replace O-ring seal.	3017010

APPENDIX III (Continued)

System	Number	Severity	Flight Squawk	Corrective Action	Part Number
Turboshaft Powerplant	1	Degraded operation.	Oil leak on No. 1 engine side of combining gearbox.	Removed/replaced covers of combining gearbox.	3017303 3017305
Turboshaft Powerplant	1	Degraded operation.	Light in No. 2 [illegible] N_g indicator inoperat[illegible]	Removed/replaced N_g indicator.	8DJ81LAAZ
Turboshaft Powerplant	1	Failure.	Rpm warning light illuminated and remained on.	Removed/replaced caution panel assembly.	212-070-227-1
Turboshaft Powerplant	1	Failure.	Ice indicator illuminated and remained on.	Removed/replaced caution panel assembly.	212-070-227-1
Turboshaft Powerplant	1	Air abort.	No. 2 engine oil pressure warning light illuminated.	Removed/replaced oil pressure switch.	7G186
Turboshaft Powerplant	5	Degraded operation.	N_f trim (beep range) too high or low.	Adjusted beep actuator.	SYLC9868
Turboshaft Powerplant	1	Degraded operation.	Idle stop stuck in retracted position.	Cleaned and lubricated plunger.	209-062-761-1
Turboshaft Powerplant	1	Degraded operation.	No. 2 engine flight idle 65 percent.	Adjusted engine idle.	- - -
Turboshaft Powerplant	1	Degraded operation	No. 2 idle stop set at 57-percent N_g.	Adjusted flight idle stop.	A900
Turboshaft Powerplant	1	Degraded operation.	No. 1 engine exceeded 100.5-percent N_g allowable at topping.	Adjusted torque turns.	212-061-001-1
Turboshaft Powerplant	1	Degraded operation.	Torque 10 percent low at topping.	Adjusted torque control unit 1/2-turn clockwise.	3014929
Turboshaft Powerplant	1	Degraded operation.	No. 2 engine would not top in N_g. Obtained 98.5 percent.	Rerigged No. 2 throttle.	212-060-724-39
Turboshaft Powerplant	1	Degraded operation.	No. 1 engine overtoped (101-percent N_g, 810 ITT), but torque was 58 percent with 60 percent required.	Compressor-washed No. 1 engine.	212-061-001-1
Turboshaft Powerplant	1	Degraded operation.	6-percent N_g rise at 5,000 feet.	Adjusted interconnect link.	3014951
Turboshaft Powerplant	1	Degraded operation.	No. 1 engine 2 percent low on torque at topping.	Engine washed.	- - -
Turboshaft Powerplant	1	Ground abort.	N_r did not join N_f.	Repaired broken wire on rotor tach generator.	- - -
Turboshaft Powerplant	2	Failure.	No. 2 engine topped with T_5 limiter circuit breaker pulled.	Removed/replaced T_5 limiter.	30186.3
Turboshaft Powerplant	4	Degraded operation.	No. 2 throttle too stiff.	No. 2 throttle, gears, and linkage adjusted.	212-001-165-3
Turboshaft Powerplant	1	Failure.	No. 1 and 2 particle separator doors did not close on engine shutdown.	Removed/replaced actuators.	209-062-214-1
Turboshaft Powerplant	1	Ground abort.	No. 1 and 2 engine chip detector light came on after engine start.	Removed, cleaned, and reinstalled chip detector.	3019373
Turboshaft Powerplant	1	Air abort.	No. 1 oil pressure light illuminated in flight.	Removed/replaced engine power section.	T400-CP-400
Turboshaft Powerplant	1	Ground abort.	Excessive oil leak, No. 1 engine N_f tach generator.	Corrected when engine replaced (not for maintenance).	- - -

APPENDIX I⁻⁷ (Continued)

System	Number	Severity	Flight Squawk	Corrective Action	Part Number
Rotary Wing Drive	1	Air abort.	Transmission oil system pressure went to zero.	Removed/replaced oil filter gasket.	48-431-629-1
Rotary Wing Drive	1	Failure.	Low rpm warning light inoperative.	Removed/replaced low rpm warning detector.	209-075-326-1
Rotary Wing Drive	4	Air abort.	Main transmission oil temperature too high.	Removed/replaced temperature bulb, oil temperature indicator.	MS-28034-3 124-972A
Electrical Power Supply	6	Degraded operation.	No. 2 generator went off the line periodically.	Adjusted paralleling rheostats.	M22-03-00011UB
Electrical Power Supply	1	Air abort	No. 1 generator dropped off the line.	Adjusted paralleling rheostats.	M22-03-00011UB
Electrical Power Supply	1	Failure.	Main inverter failed to develop voltage.	Removed/replaced main inverter.	MS 17406-1
Lighting	1	Failure.	Anticollision light did not light.	Removed/replaced.	G-8400A8-245
Lighting	1	Degraded operation.	Searchlight was sticking in lateral sweep.	Could not duplicate.	212-075-200-1
Hydraulic Power Supply	1	Degraded operation.	No. 1 hydraulic system light came on inflight.	New pressure switch installed.	7G247
Hydraulic Power Supply	1	Failure.	No. 1 flight control hydraulic filters leaked.	Replaced integrated value and filter assembly.	212-077-006-1
Fuel	1	Failure.	Right boost pump failed.	Removed/replaced boost pump.	RG12240D
Fuel	1	Ground abort.	Right boost pump failed; circuit breaker wouldn't reset.	Wiring corrected.	- - -
Fuel	1	Degraded operation.	No. 1 fuel boost pump warning light came on.	Removed/replaced fuel flow switch.	MS25089-4C
Instruments	1	Failure.	Heading indicator inoperative first portion of flight.	Could not duplicate.	- - -
Instruments	2	Degraded operation.	Attitude indicator inoperative first portion of flight.	Removed/replaced roll and pitch displacement gyro.	MD-1
Instruments	1	Degraded operation.	RMI took 30 minutes to align properly.	Removed/replaced amplifier.	AM6015A
Instruments	1	Degraded operation.	Pilot's attitude indicator slow to erect.	Removed/replaced attitude indicator.	212-070-714-1
HF Communications	2	Failure.	HF set inoperative; no side tone.	Removed/replaced receiver-transmitter unit.	RT-698/ARC-102
HF Communications	1	Failure	Unable to transmit at any time.	Removed/replaced antenna coupler.	CU-1658/A
VHF Communications	3	Degraded operation.	VHF-AM sidetone cut in and out.	Removed/replaced radio set.	AN/ARC-115
VHF Communications	2	Failure.	VHF-AM reception very broken and garbled.	Removed/replaced radio set.	AN/ARC-115
VHF Communications	1	Failure.	VHF-FM not operable.	Removed/replaced radio set.	AN/ARC-114
VHF Communications	2	Failure.	VHF-AM sidetone broke when transmitting.	Removed/replaced radio set.	AN/ARC-115
VHF Communications		Failure.	VHF-FM unable to transmit.	Could not duplicate.	- - -
UHF Communications	1	Degraded operation.	UHF had high background noise.	Could not duplicate malfunction.	- - -

APPENDIX III (Concluded)

System	Number	Severity	Flight Squawk	Corrective Action	Part Number
UHF Communications	1	Degraded operation.	Intermittent.	Could not duplicate malfunction.	- - -
UHF Communications	1	Failure.	UHF transmitter extremely weak and garbled.	Removed/replaced radio set.	AN/ARC-116
UHF Communications	1	Failure.	Could not contact tower.	Removed/replaced radio set.	AN/ARC-116
UHF Communications	1	Failure.	No sidetone when transmitting.	Removed/replaced radio set.	AN/ARC-116
UHF Communications	1	Degraded operation.	High background noise when transmitting.	Could not duplicate malfunction.	- - -
UHF Communications	1	Degraded operation.	Unable to hear 309.5.	Could not duplicate malfunction.	- - -
Interphone	1	Degraded operation.	Copilot's foot switch inoperative.	Cleaned foot switch.	205-075-520-1
Tacan	1	Failure.	Tacan DME inoperative.	Removed/replaced antenna.	AT-741/A
Tacan	3	Failure.	Tacan DME inoperative.	Removed/replaced receiver-transmitter.	RT-471/ARN-65
UHF Direction Finder	1	Failure.	No. 1 needle went to 45 degrees right.	Removed/replaced antenna.	AS-909/ARA-48
UHF Direction Finder	2	Failure.	No. 1 needle went to a point 10 degrees right of nose.	Removed/replaced amplifier.	AM-3624/ARA-50
VOR	1	Degraded operation.	VOR oscillated ±5 degrees.	Repair deferred.	R-1388/ARN-82
Rocket Launcher	1	Air abort.	Left rocket pod failed to fire rocket.	Tightened loose connector.	- - -
Rocket Launcher	1	Degraded operation.	Manual LAU-59 jettison too stiff.	Pod jettison cable travel shortened at turnbuckle.	MS21251-26

APPENDIX IV
CALCULATION OF SUBSYSTEM MISSION RELIABILITY

The following statistics were calculated for each subsystem:

1. Mean time between discrepancies (MTBD)
2. Mean time between failures (MTBF)
3. Mean time between aborts (MTBA)

These values were computed as follows:

$$MTBD = \frac{T}{N_d + N_f + N_a}$$

$$MTBF = \frac{T}{N_f + N_a}$$

$$MTBA = \frac{T}{N_a}$$

where:

T = total system operating (flying) time.

N_d = number of missions on which degraded operation was recorded against the subsystem.

N_f = number of missions on which a no-abort failure was recorded against the subsystem.

N_a = number of missions on which an abort was recorded against the subsystem.

In addition, the statistically derived 90-percent lower confidence limits (LCL's) for the means were calculated. A 90-percent LCL for a given parameter is that value which the true value would equal or exceed for a given sample size with 90-percent probability. Thus, the proximity of the 90-percent LCL to the measured mean gives an indication of the certainty that should be attached to the measured mean. In other words, the closer the measured value is to the 90-percent LCL, the greater the certainty that the measured value will be the true value.

The method used to determine the LCL employed the chi-square (χ^2) distribution, using fixed truncation time for the tests:

$$\text{Lower Limit} = \frac{2T}{\chi^2\ (\alpha,\ 2R + 2)}$$

Where:

T = total system operating time

R = number of failures accumulated

α = acceptable risk of error (10 percent) or

$1-\alpha$ = confidence level (90 percent)

χ^2 = the critical value for the chi-square distribution with risk, α, and the degrees of freedom, $2R + 2$.

An iterative method was used to solve the equation for the LCL. Any large differences between some of the measured mean times and the associated LCL's resulted from the low malfunction rates of some subsystems.

The following formula was used to calculate overall aircraft mean time between subsystem failures:

$$\text{Mean Time Between Subsystem Failures} = \frac{\text{Total Flying Time}}{\sum\limits_{\text{all subsystems}} N_f + \sum\limits_{\text{all subsystems}} N_a}$$

APPENDIX V

HARDWARE FAILURE DEFINITION

A subsystem hardware failure was initially defined as any discrepancy which was corrected by maintenance "action taken" codes F, G, K, L, P, R, S, or Z and which did not have one of the following "how malfunctioned" codes: 086, 072, 105, 106, 108, 142, 204, 230, 246, 301, 303, 424, 518, 553, 602, 709, 731, 793, 797, 798, 799, 800, 801, 802, 803, 804, 812, 877, 878, 911, and 931 (table XXXI defines these codes).

In addition to the above algorithm, which was used as a preliminary screen for failures, a manual editing technique was employed to cross check data accuracy and to further select failures. During the manual editing phase, the following types of maintenance actions were not considered failures:

1. Components which were removed from the aircraft, but tested "good" at the field maintenance level.

2. Secondary failures (those caused by the failure of a different component).

3. Correction of maintenance errors.

4. Minor maintenance actions such as replacement of missing screws, installation of safety wire, etc.

For the calculation of observed MTBF, the following formula was used:

$$MTBF = \frac{\text{Flying hours}}{\text{Observed failures}}$$

APPENDIX VI
DETERMINATION OF MAINTENANCE MANHOURS PER FLYING HOUR

WUC's were used in maintenance data recording to identify the specific hardware item that was being worked on or to identify the type of maintenance. These are five-digit alphanumeric codes specified in the Work Unit Code Manual, T.O. 1H-1(U)N-06 (reference 36). The first two digits of a WUC (called a WUC group) identify an aircraft system. For example, 71 identifies the radio navigation system. The third digit usually identifies a subsystem. For example 713 identifies the VOR subsystem. The fourth and fifth digit usually identify assemblies and components. For example, 7131A identifies the VOR receiver. Maintenance accomplished and documented against aircraft systems is called corrective maintenance. WUC's beginning with 01 through 09 identify support-general maintenance actions such as aircraft cleaning, servicing, and look phases of inspections.

The MMH/FH expended against each aircraft system and for each type of support-general maintenance was calculated. These statistics were calculated by retrieving maintenance data from the SEDS data system by the first two digits of the WUC (WUC group) and dividing the sum of maintenance manhours for each WUC group by the total flying time for the reporting period. Support-general maintenance was denoted by WUC groups 01 through 09. Corrective maintenance was denoted by WUC groups 11 through 97.

Figures 1 through 41

APPENDIX VII TEST DATA

Tables I through XXVIII

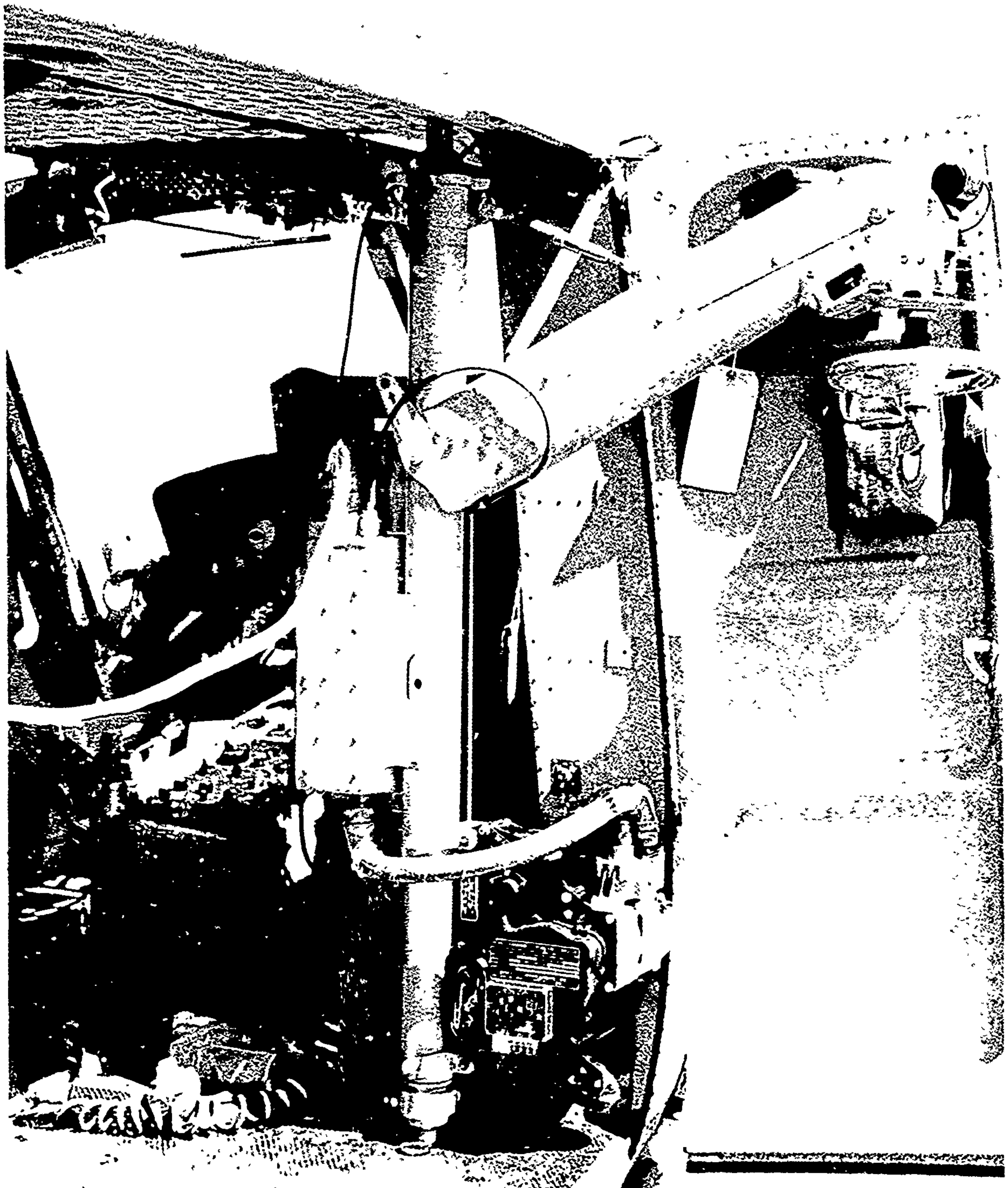


Figure 1 BL-8300 Hoist Installed in Forward Right Station

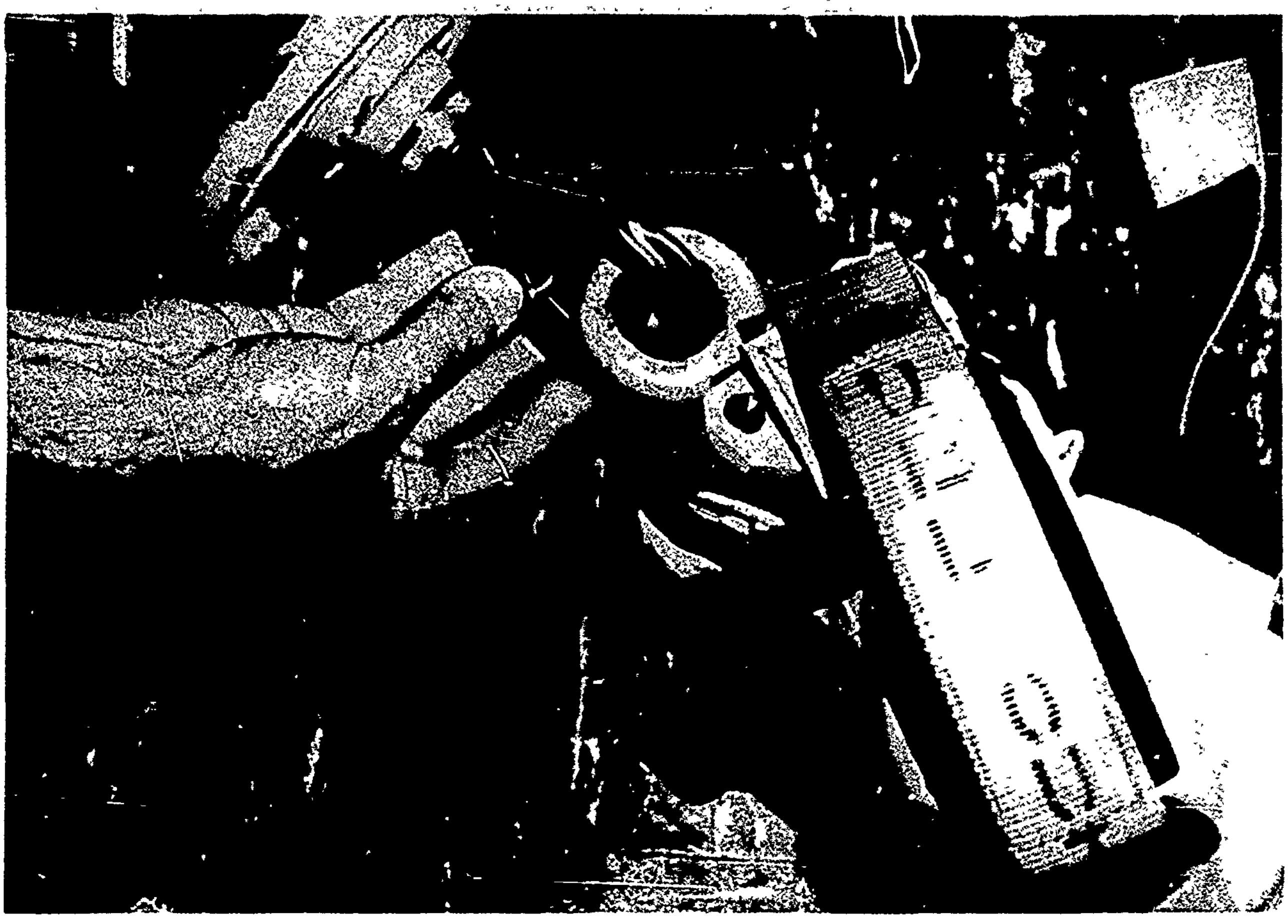


Figure 2 Hoist Hook with Forest Penetrator Attached

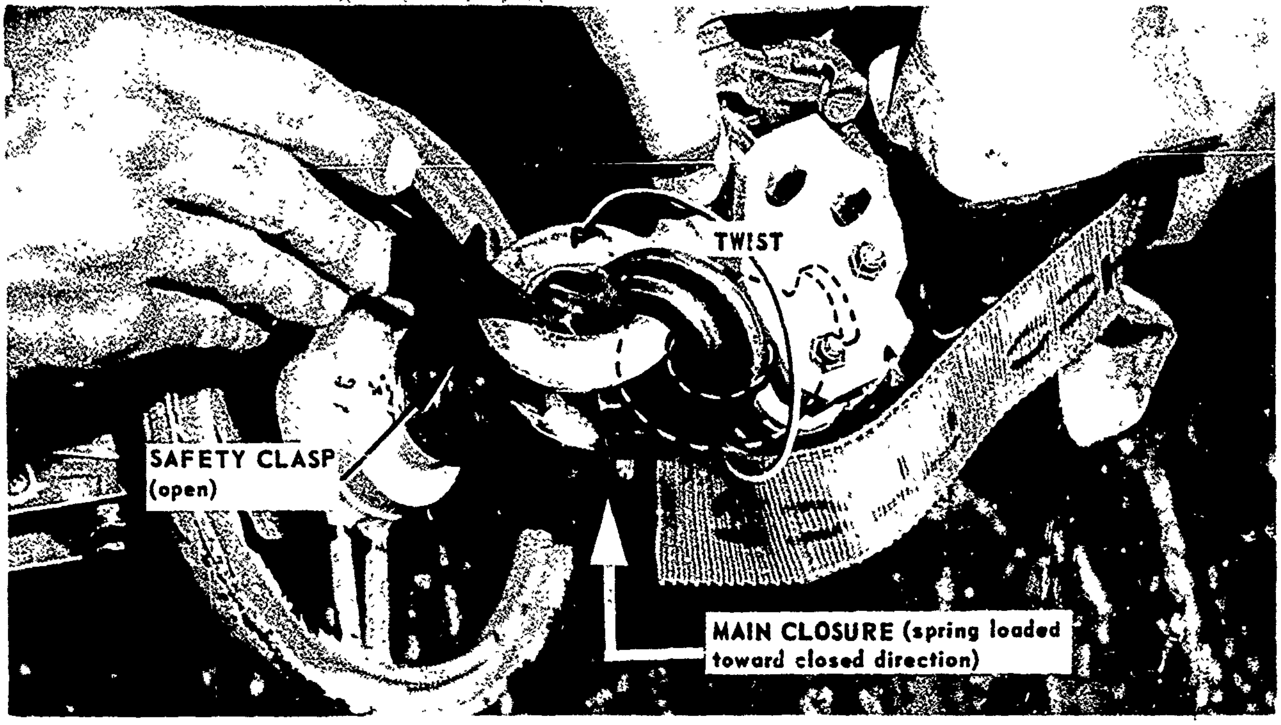


Figure 3 Self-Release of Forest Penetrator

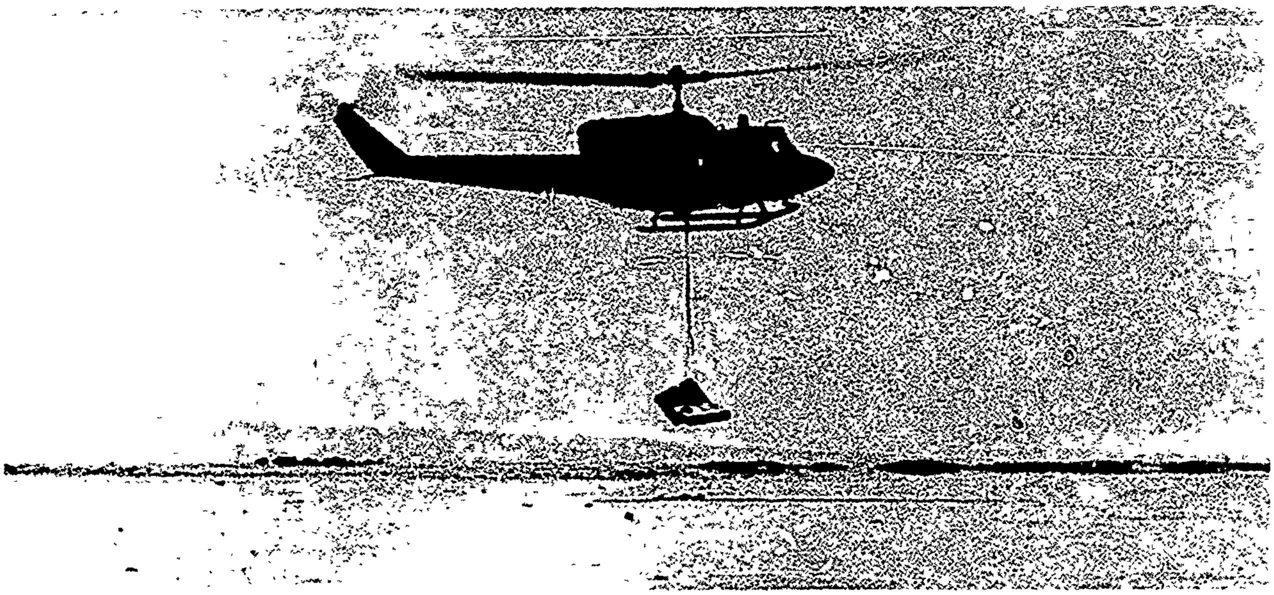


Figure 4 UH-1N Hover with External Cargo

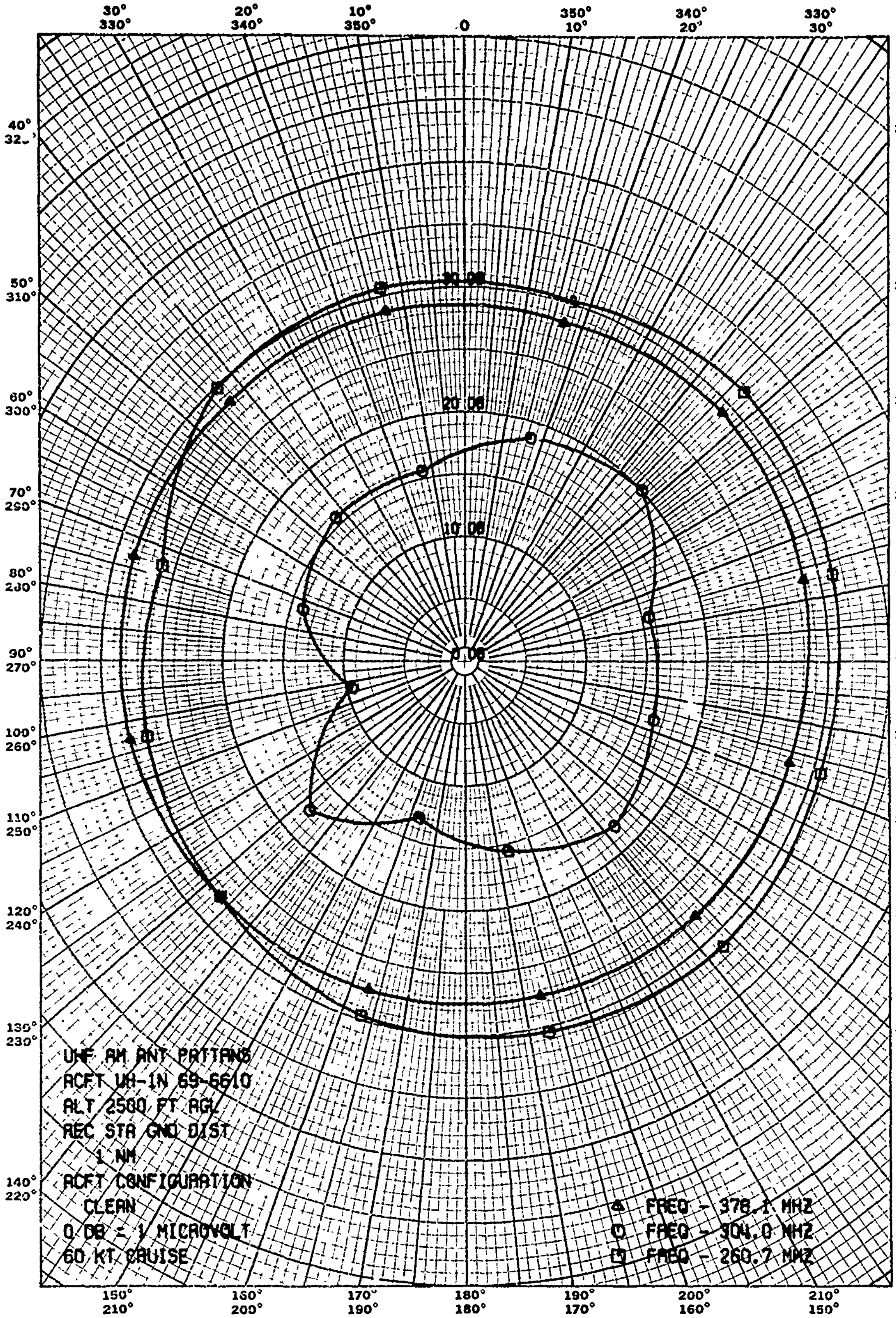


Figure 5 Pre-ECP UHF-AM Antenna Patterns

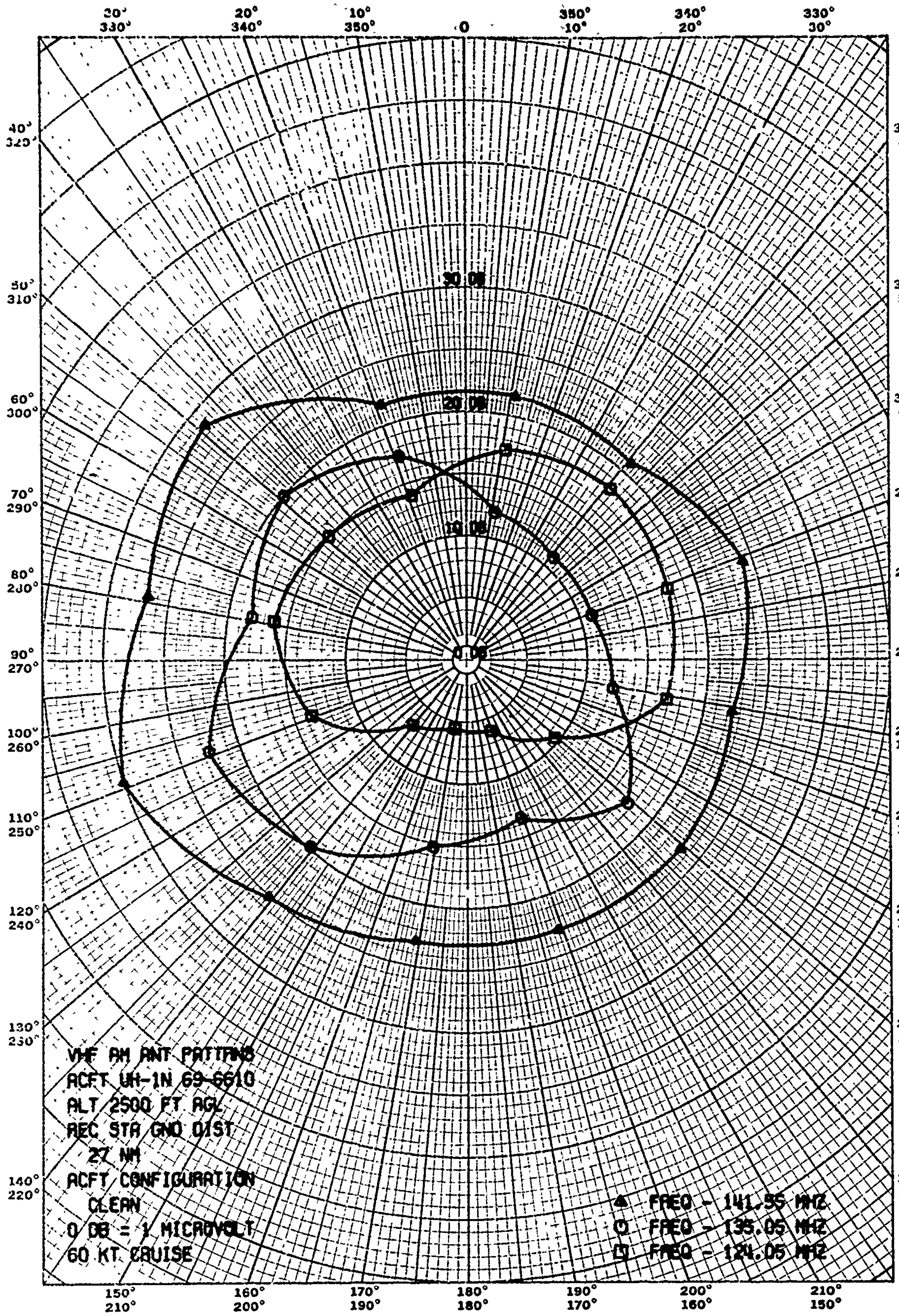


Figure 6 Pre-ECP VHF-AM Antenna Patterns

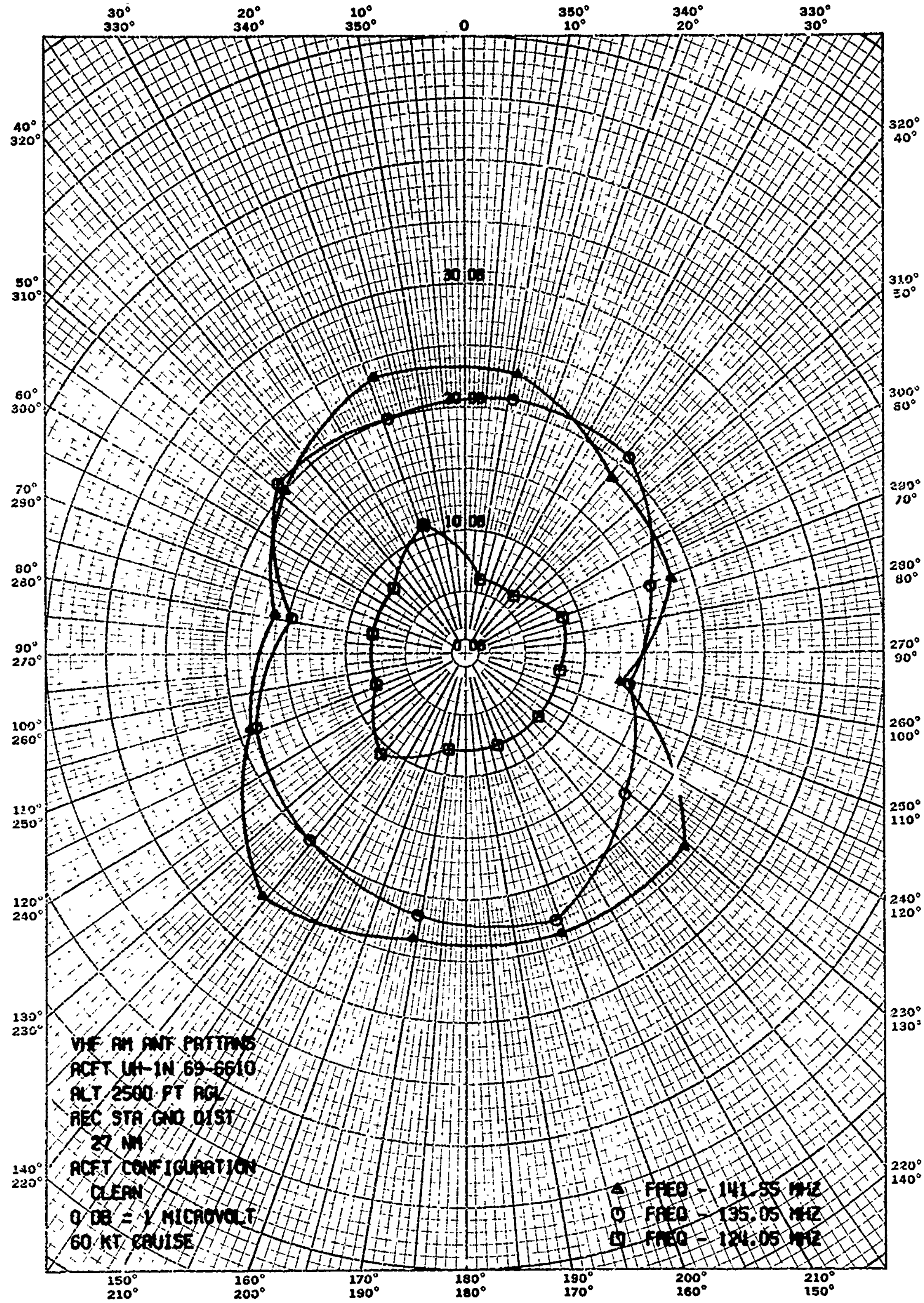


Figure 7 Post-ECP VHF-AM Antenna Patterns

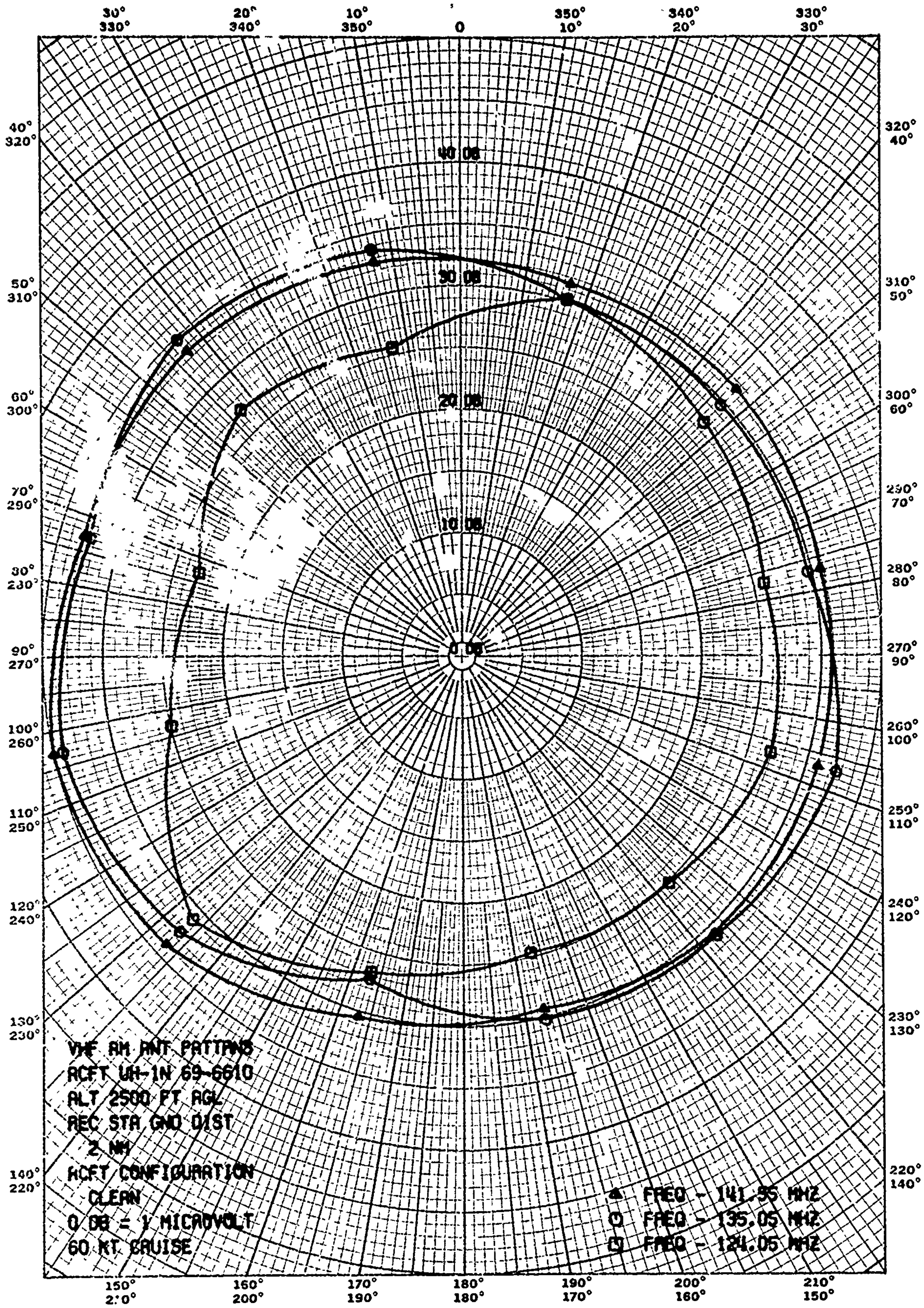


Figure 8 Post-ECP VHF-AM Antenna Patterns

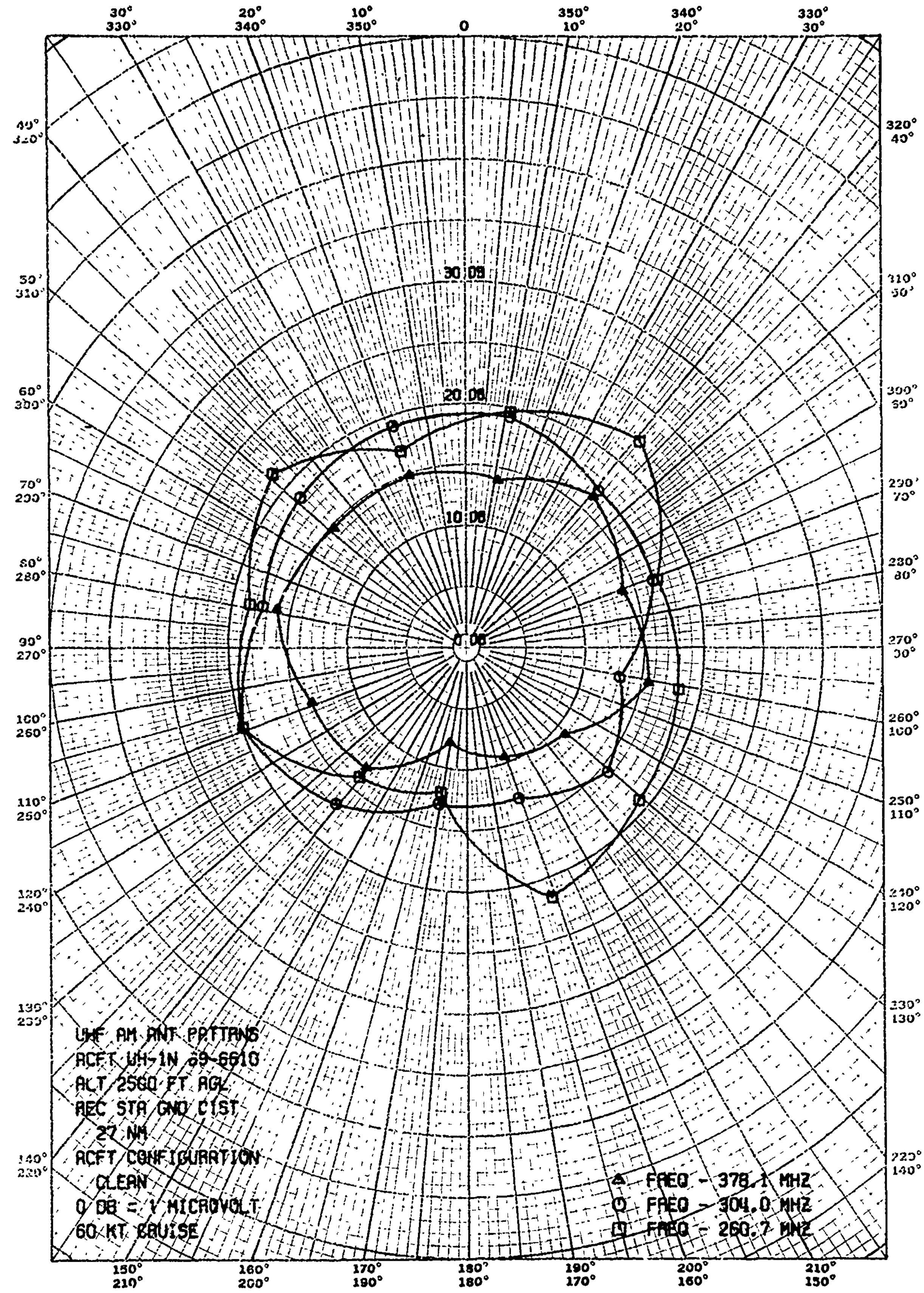


Figure 9 Post-ECP UHF-AM Antenna Patterns

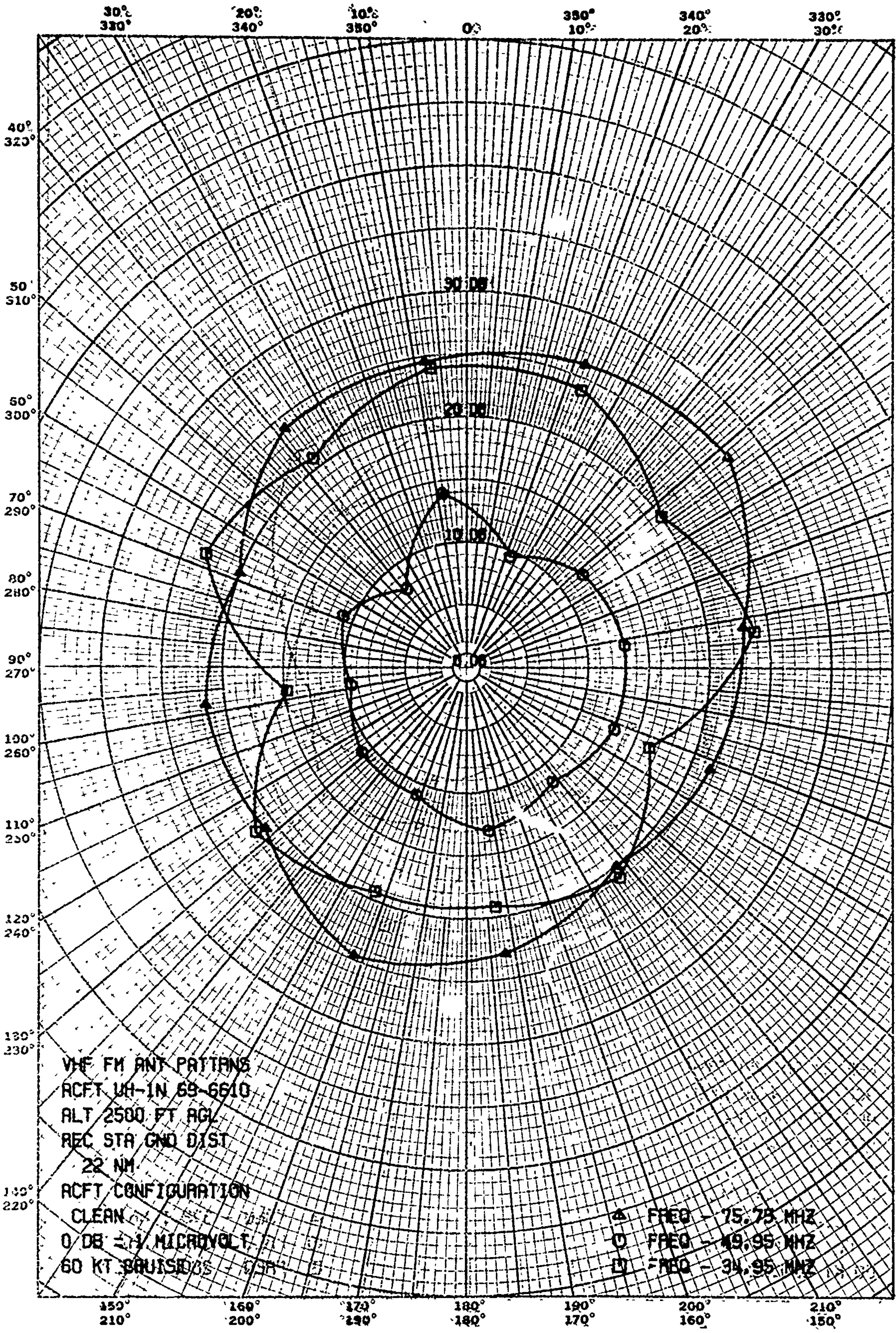


Figure 19. VHF-FM Antenna Patterns

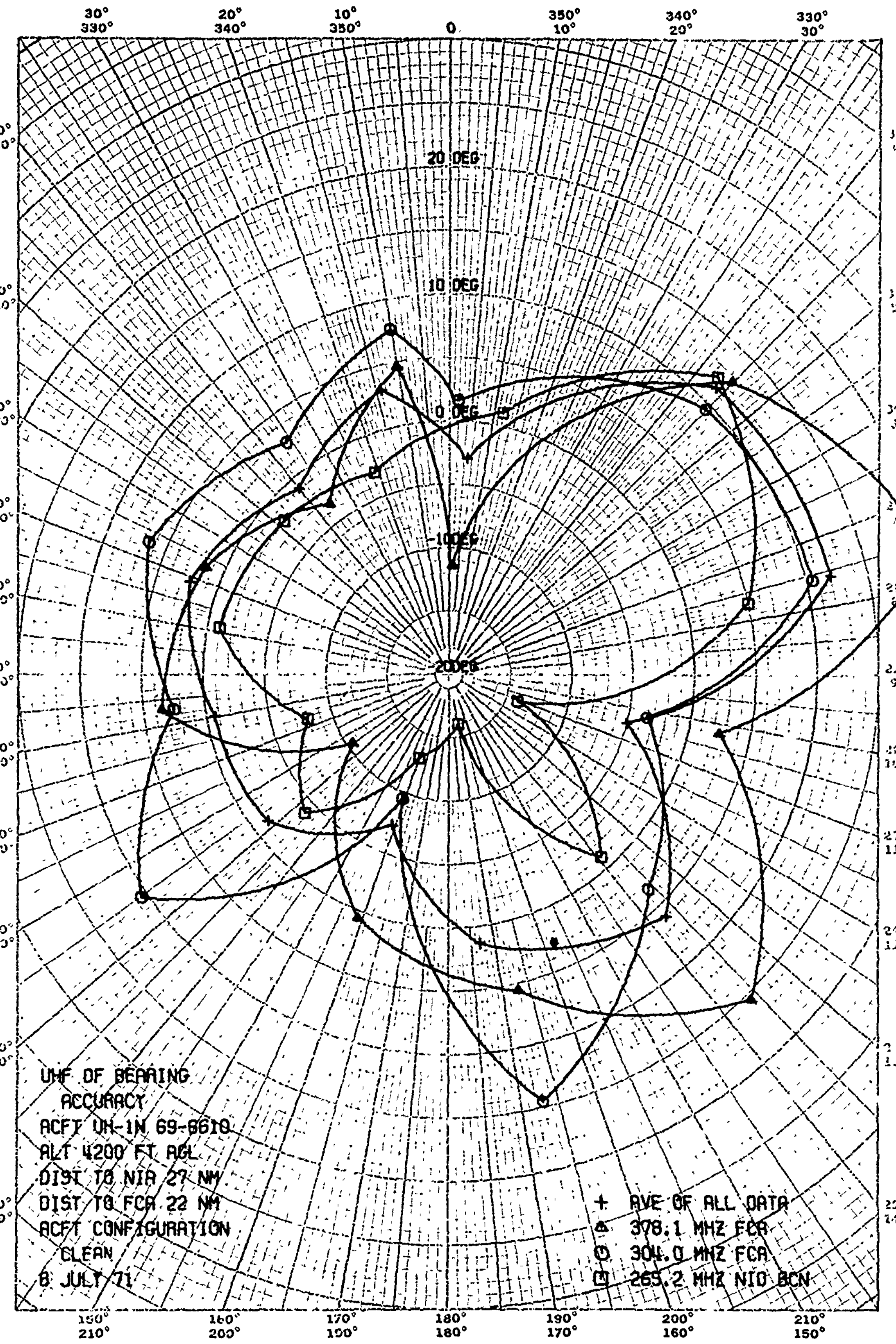


Figure 11 UHF DF Bearing Accuracy

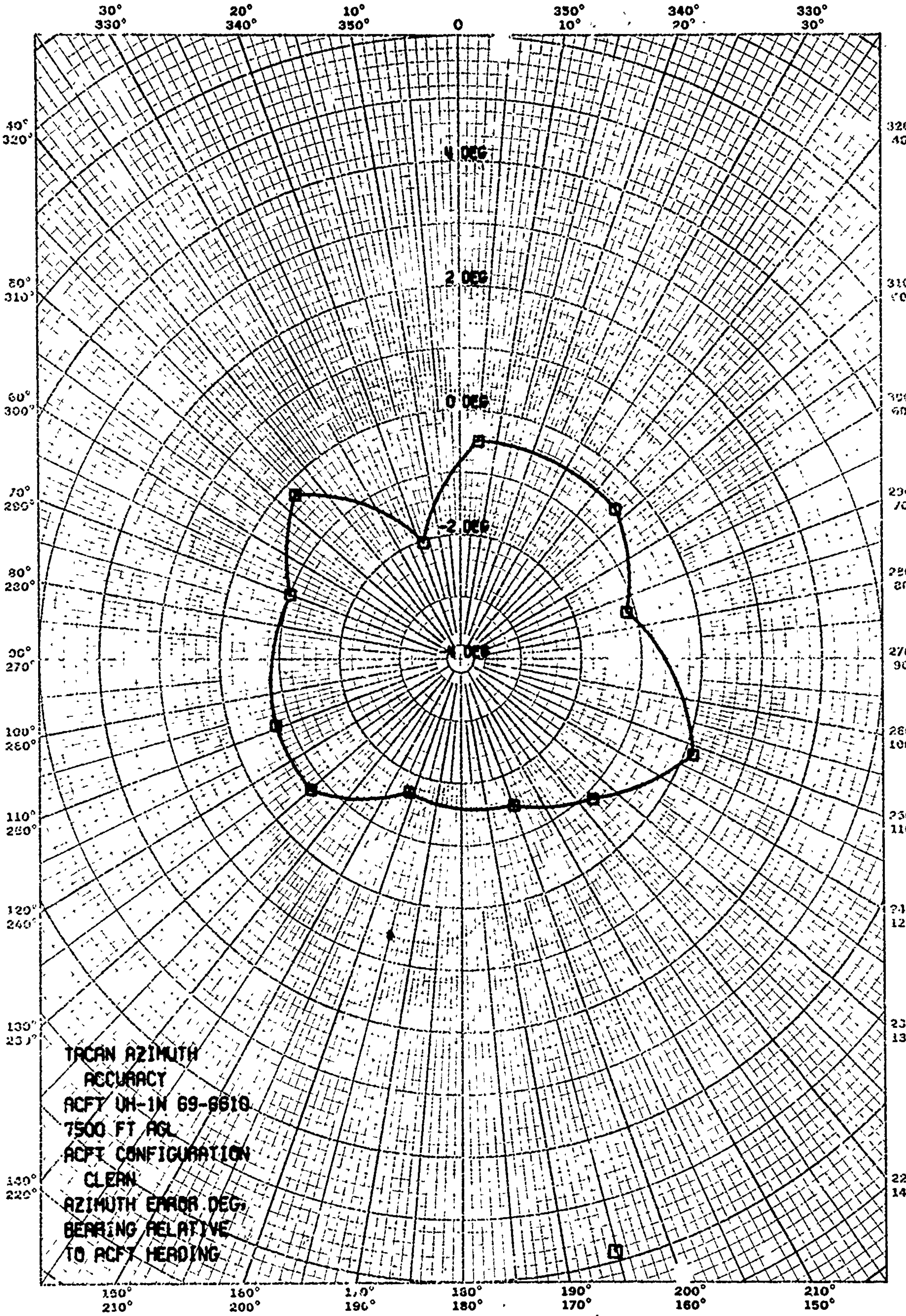


Figure 12 Tacan Radial Accuracy

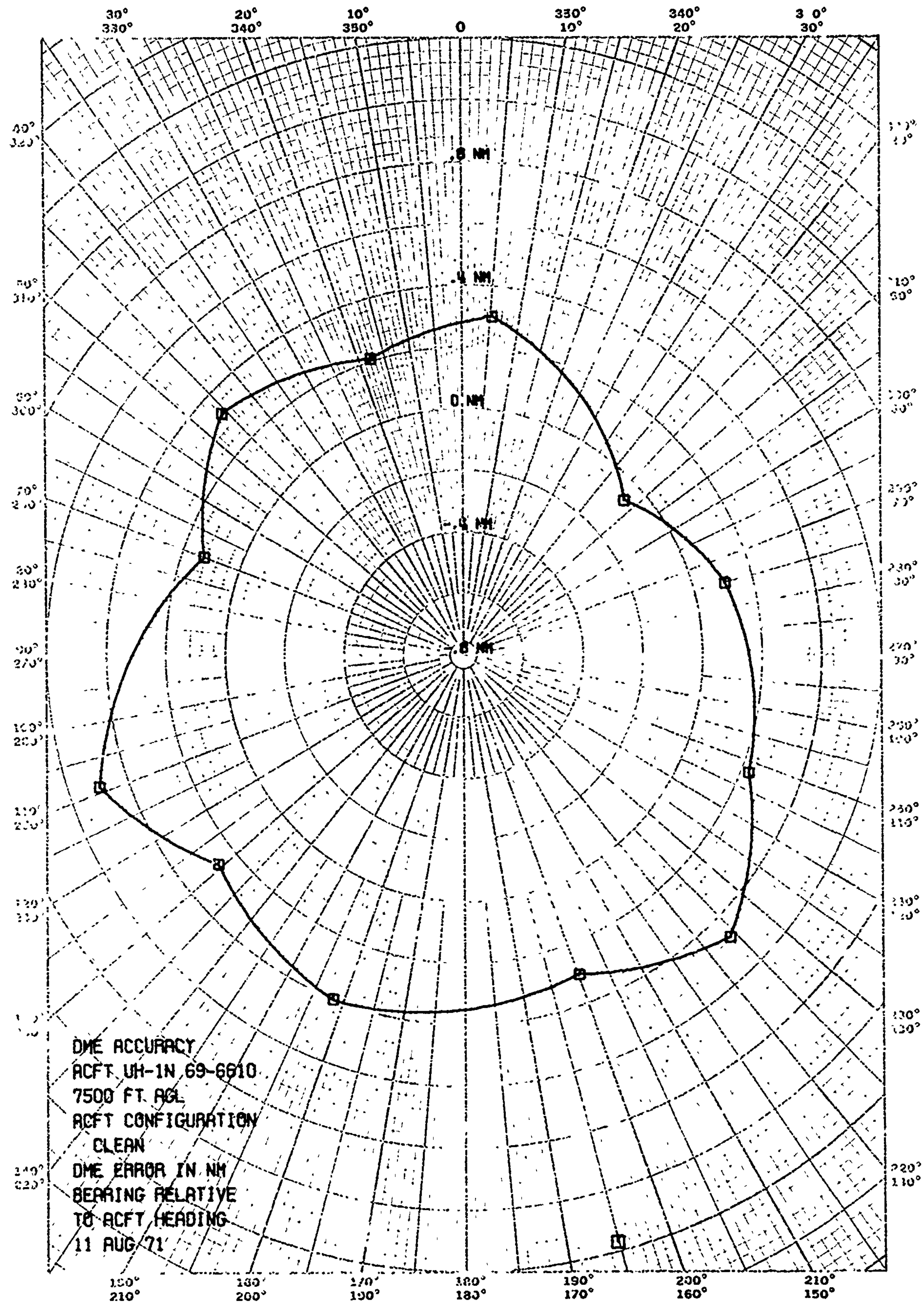


Figure 13 DME Accuracy

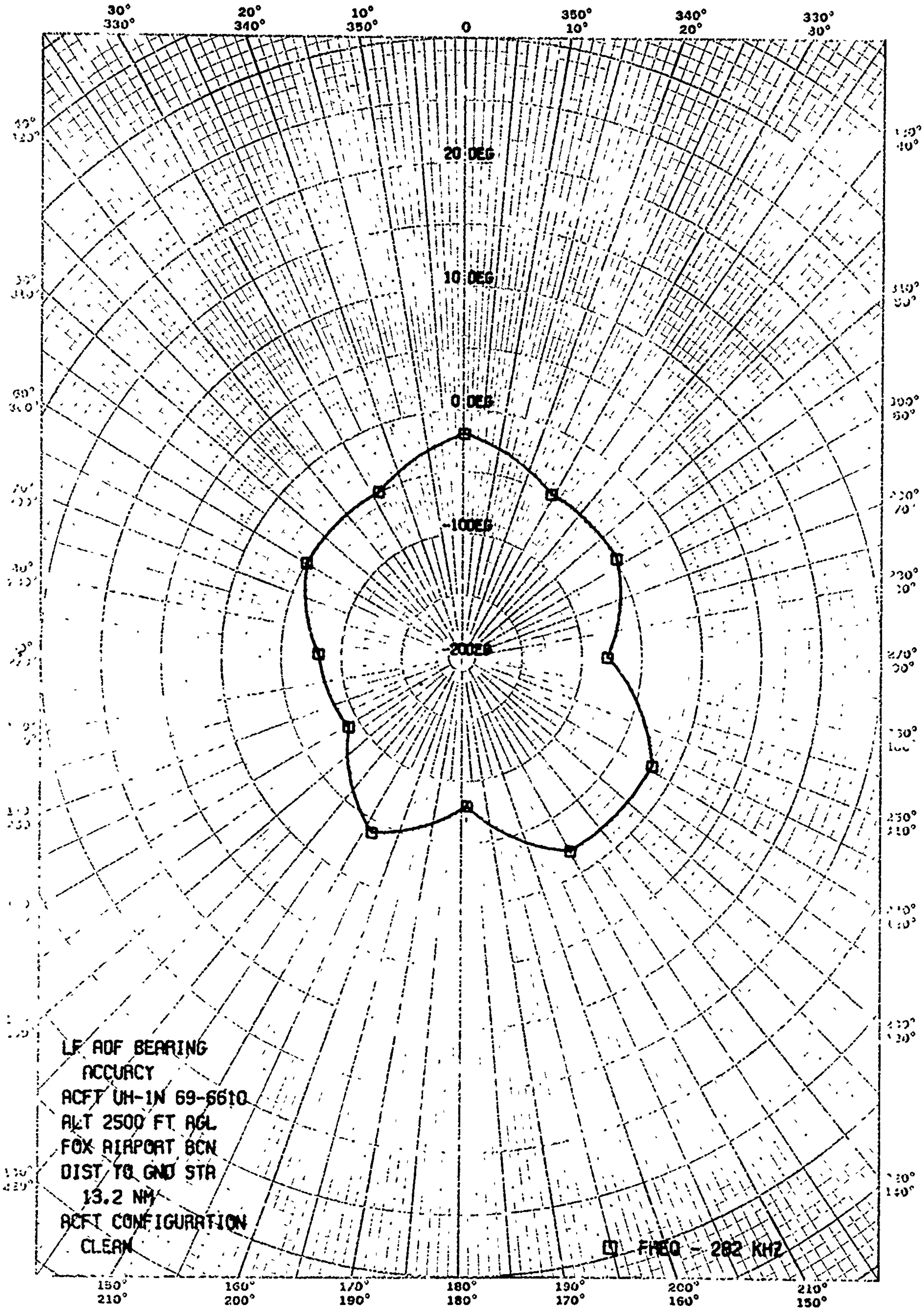


Figure 14 LF ADF Bearing Accuracy

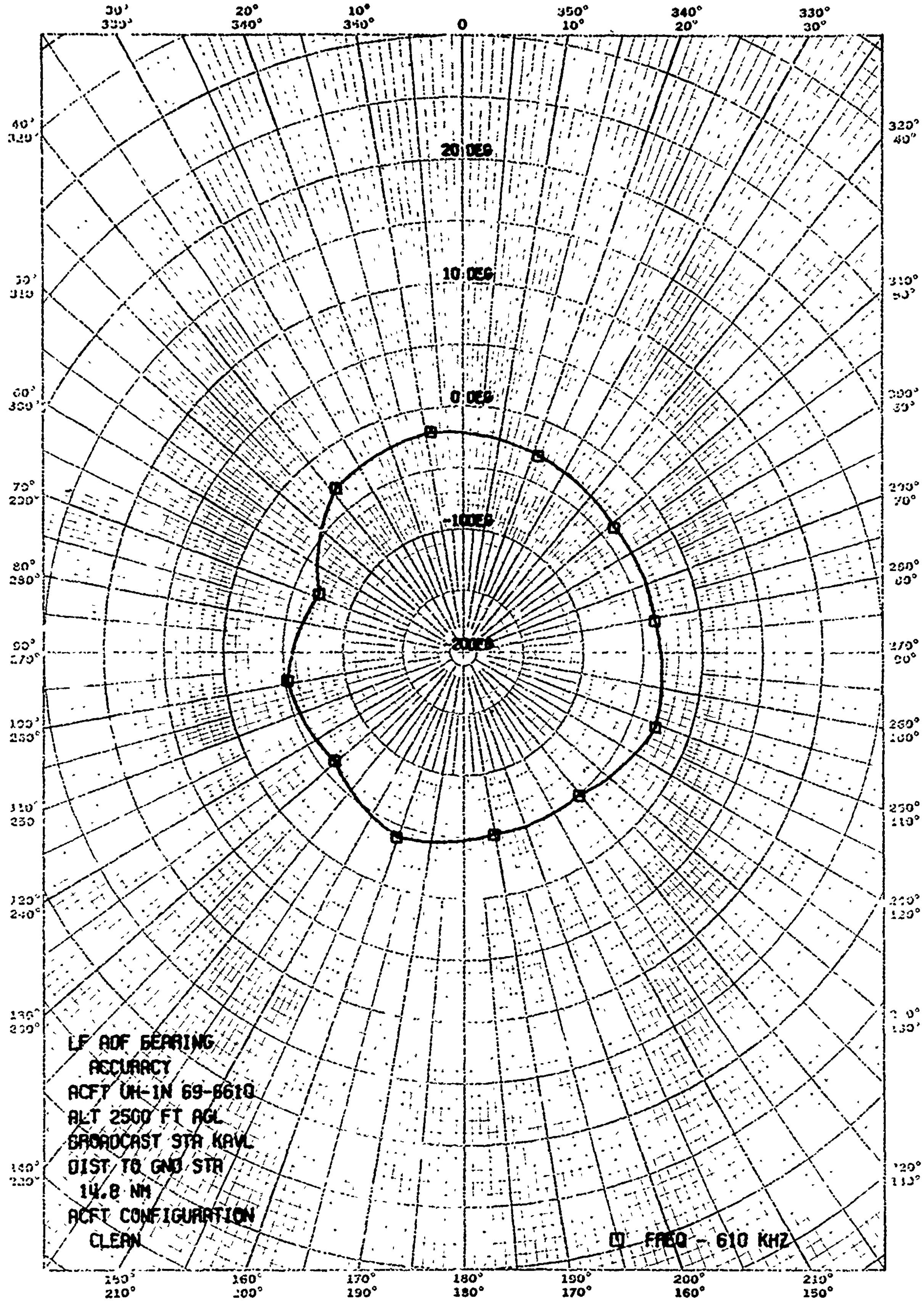


Figure 15 LF ADF Bearing Accuracy

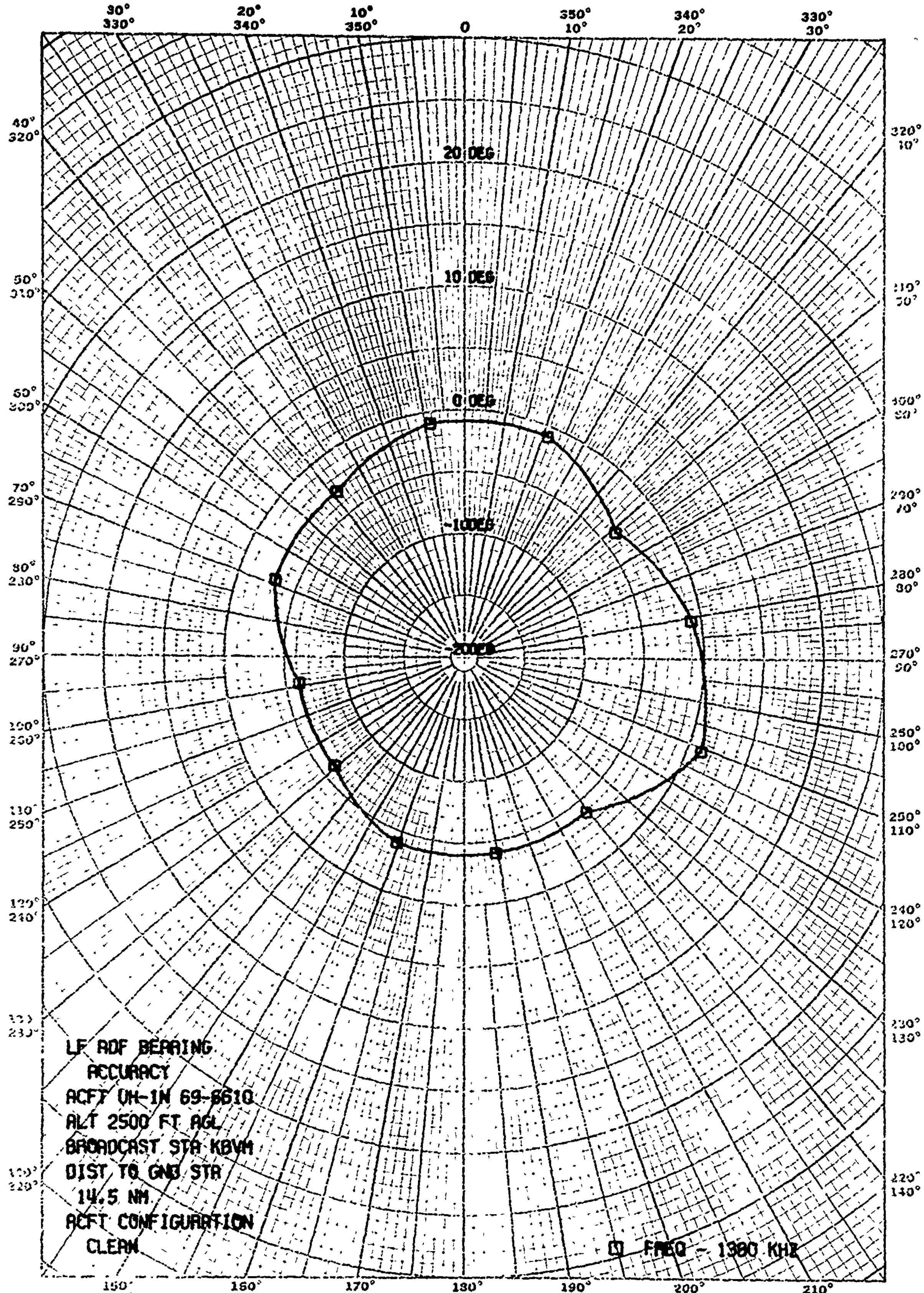


Figure 16 LF ADF Bearing Accuracy

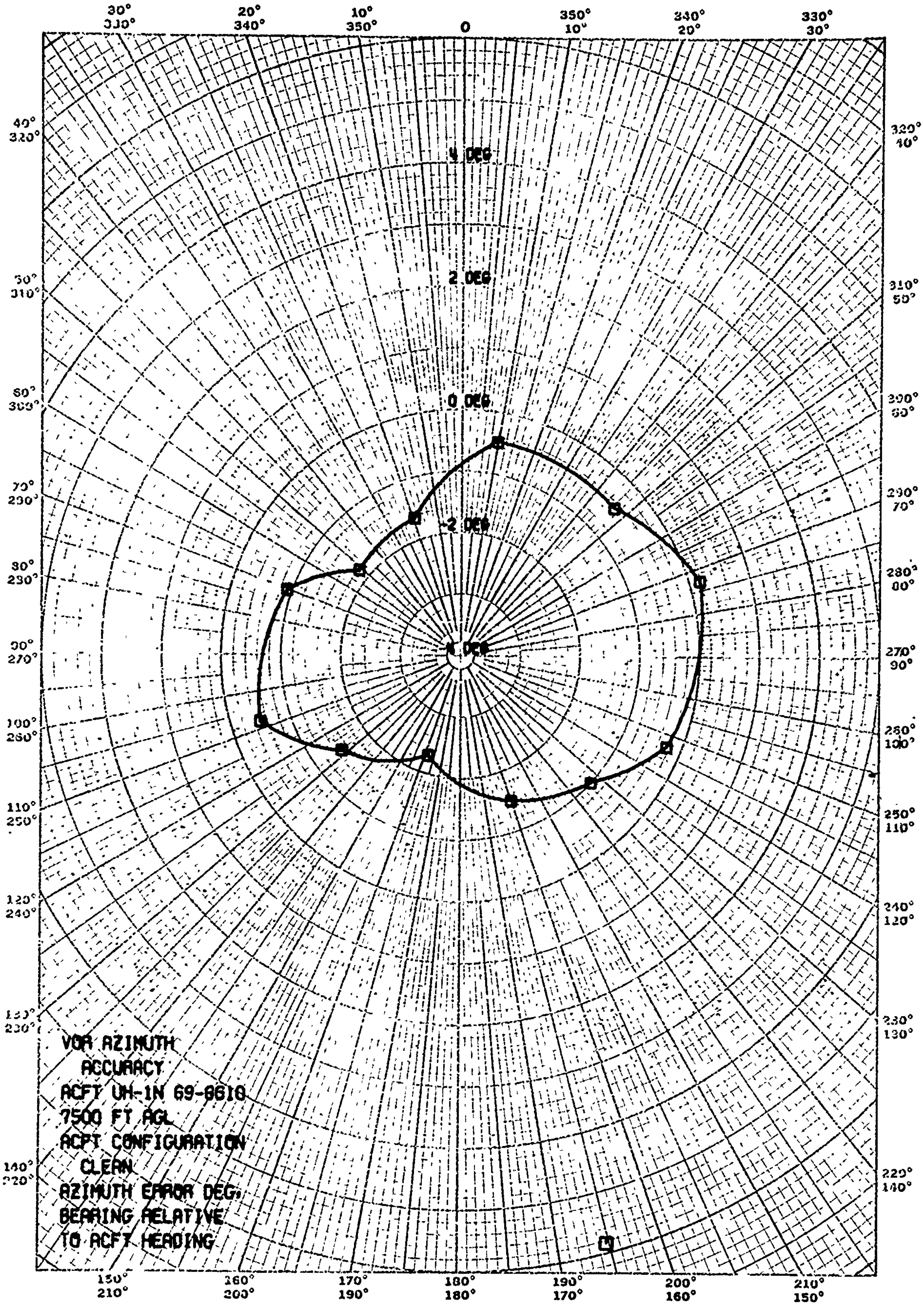


Figure 17 VOR Radial Accuracy

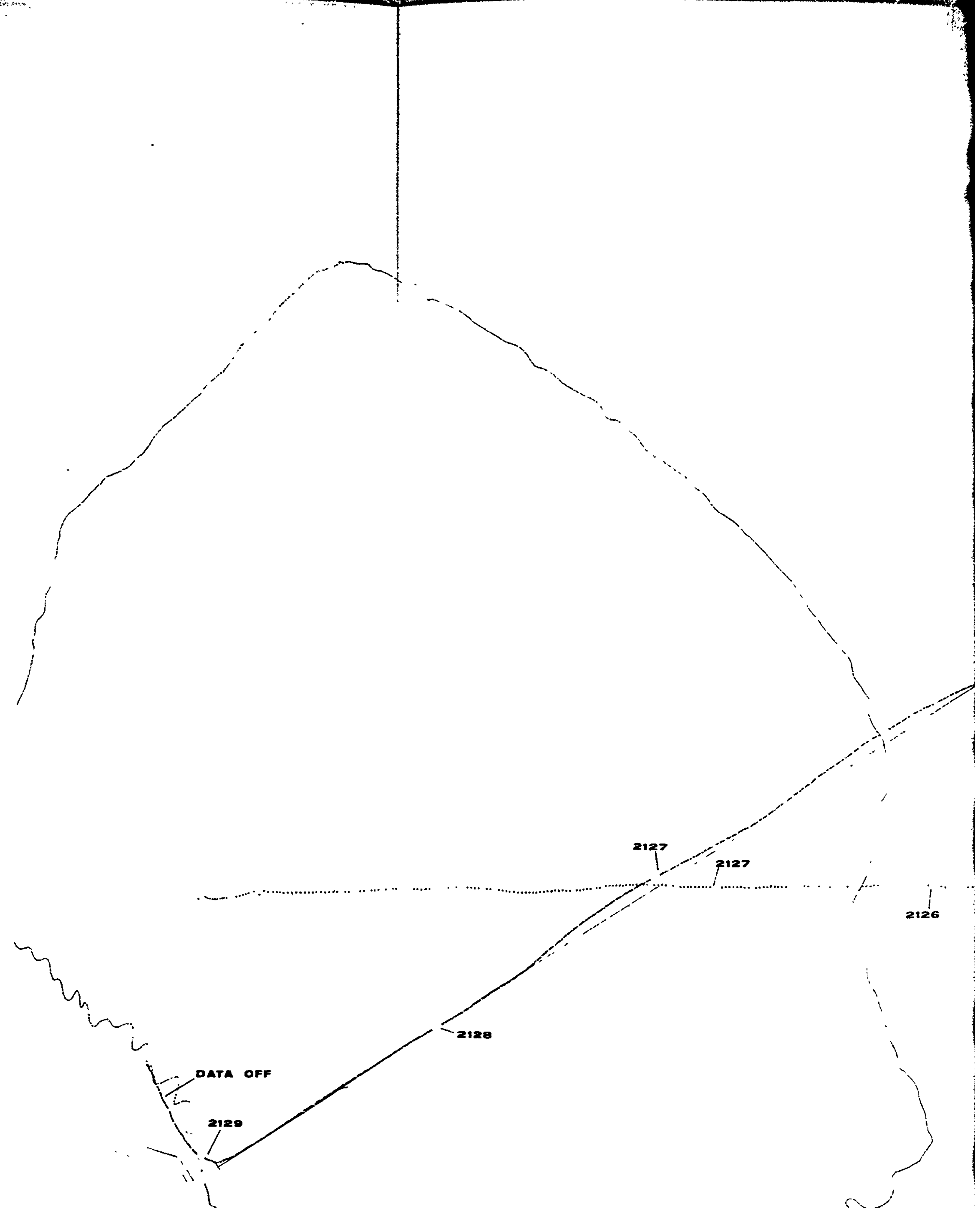
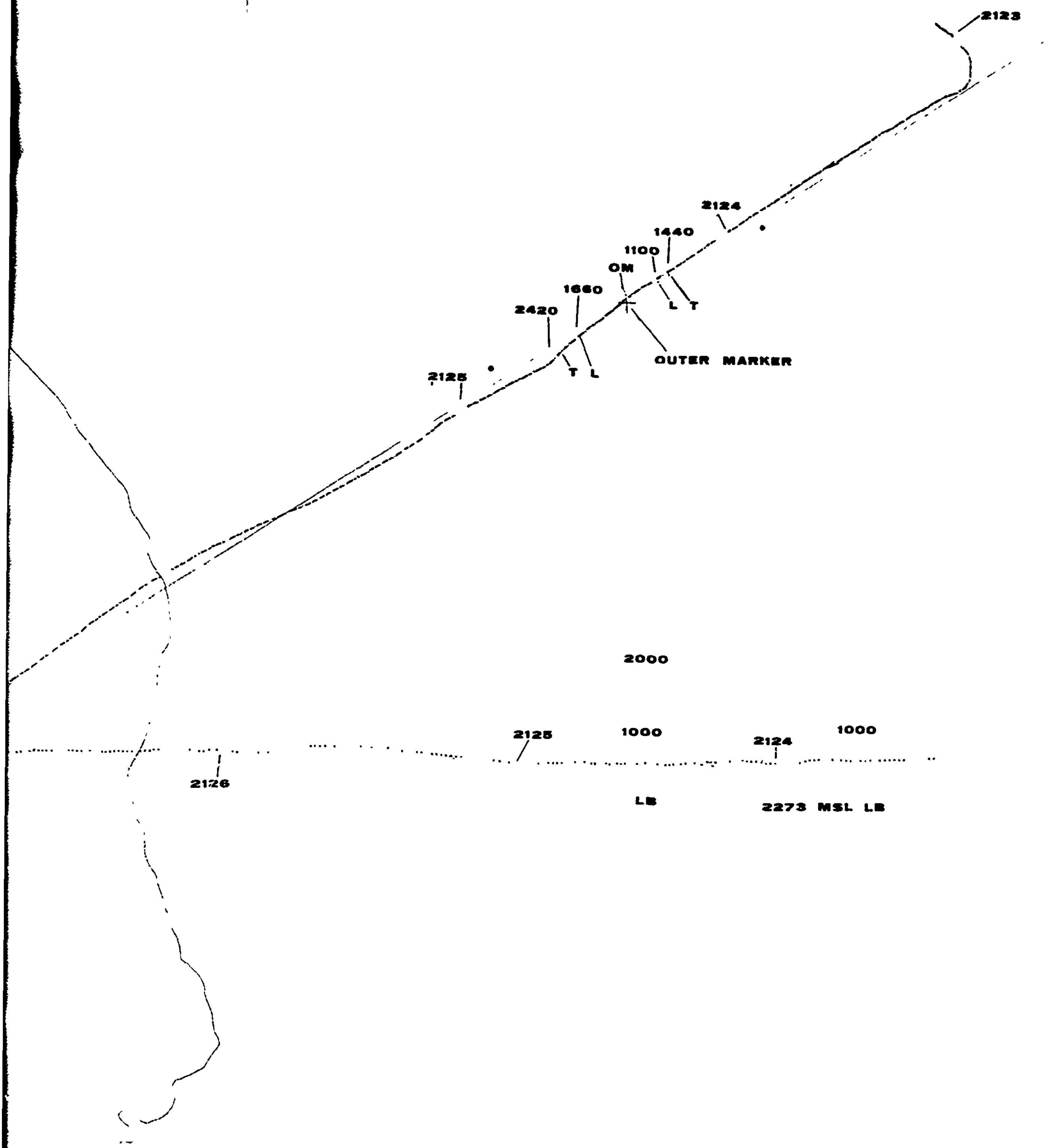


Figure 18 ILS Radar Plot



18 ILS Radar Plot

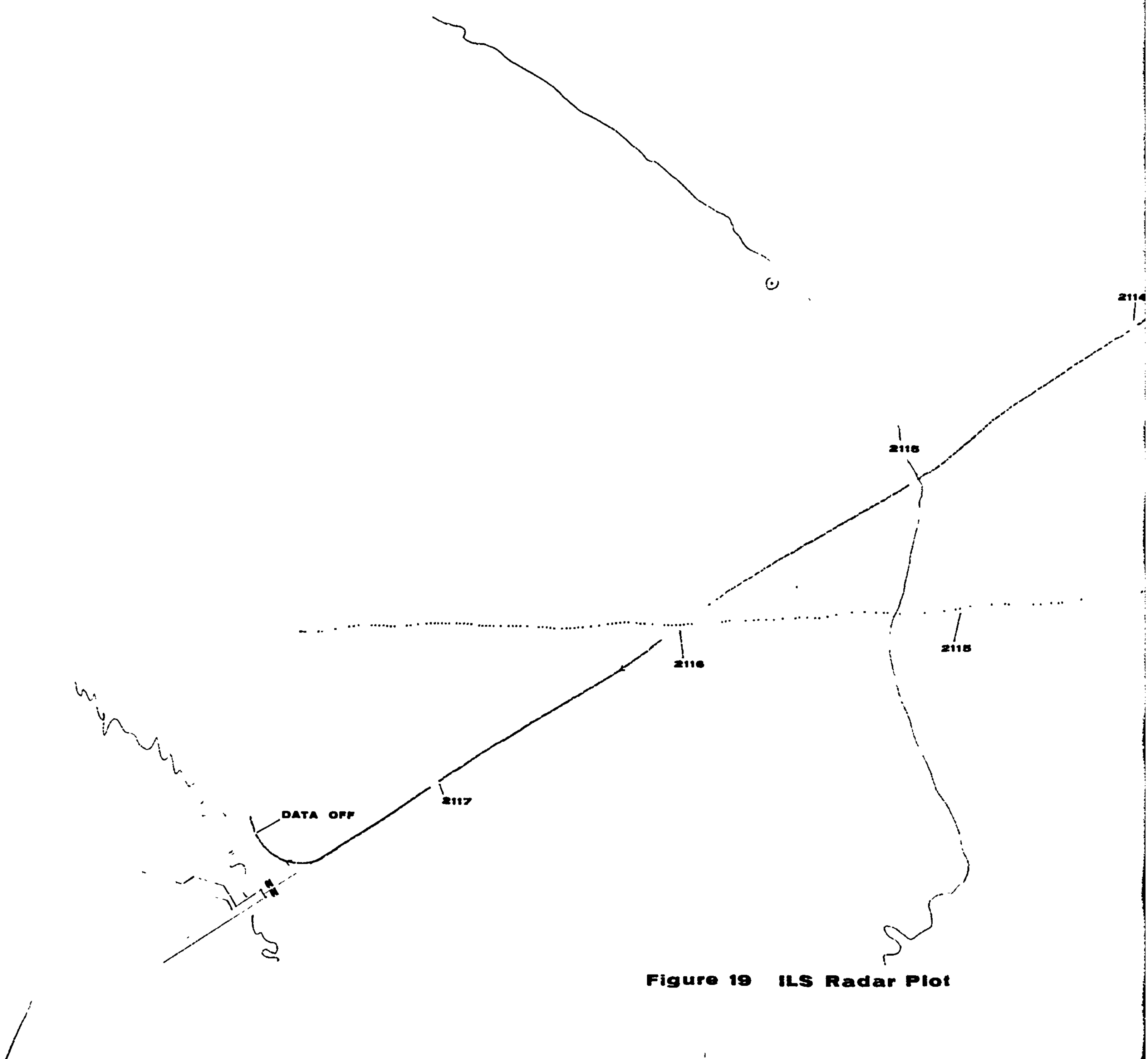
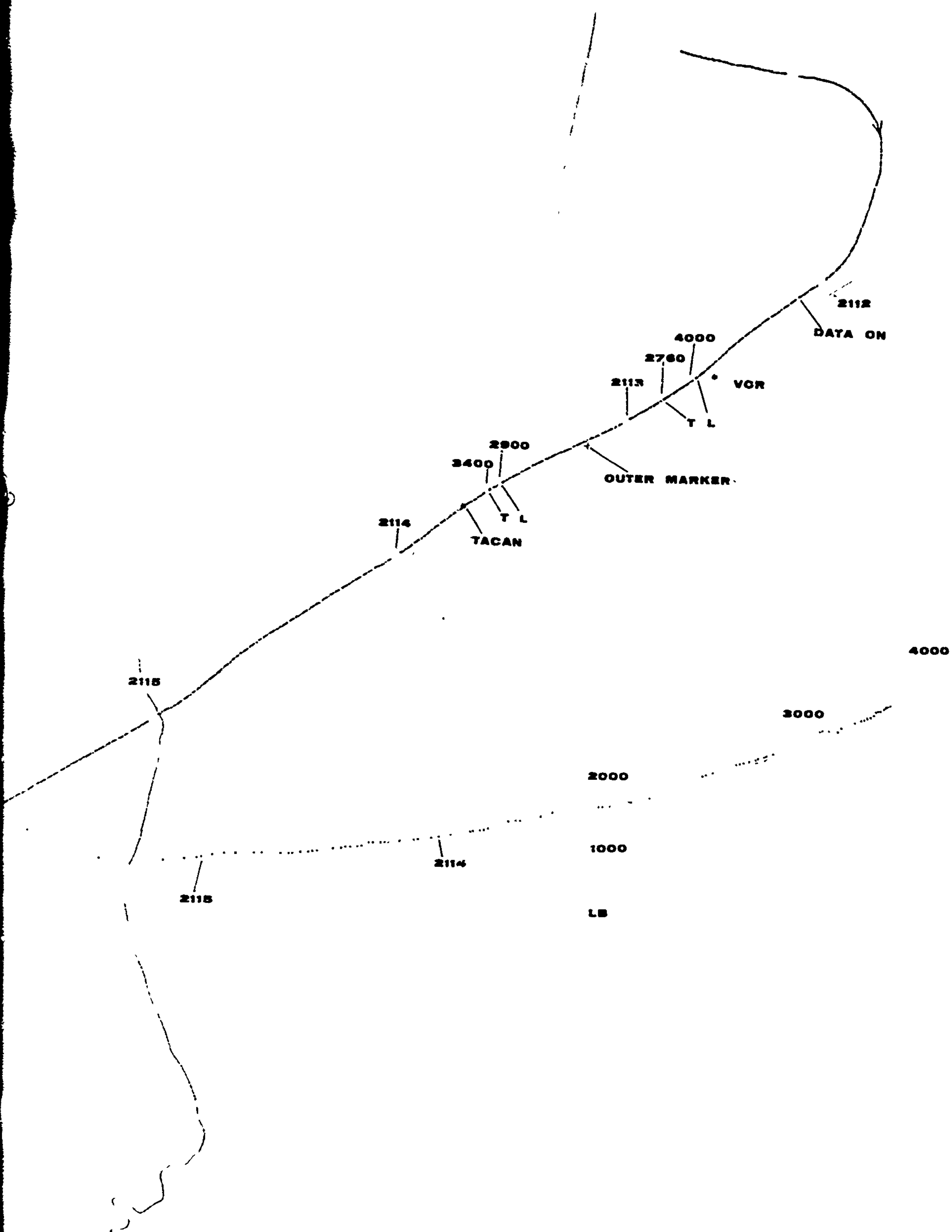


Figure 19 ILS Radar Plot



LS Radar Plot

Figure 20 Mode 2 Thumbwheels Viewed Through Left Chin Window

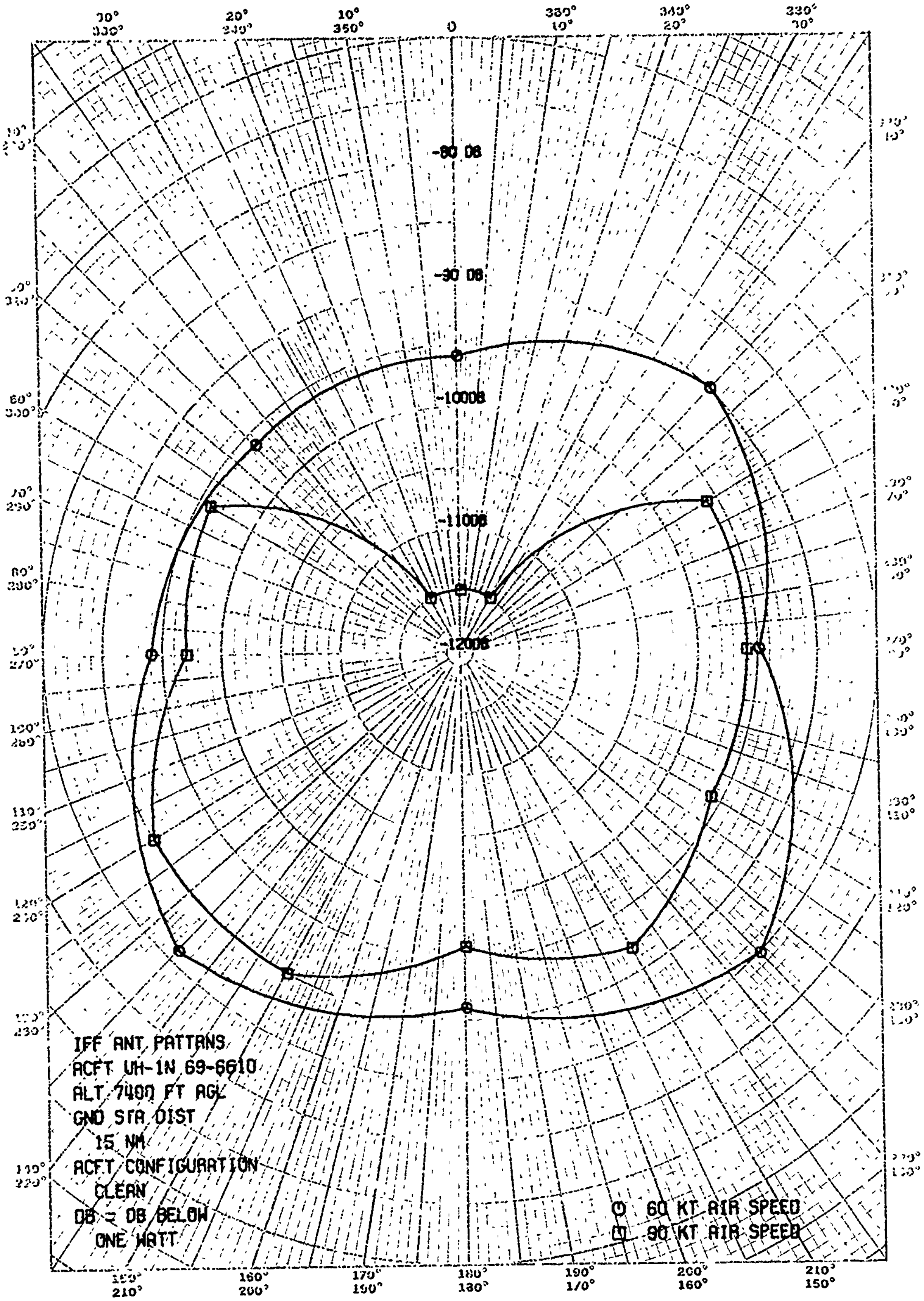


Figure 21 IFF Antenna Patterns

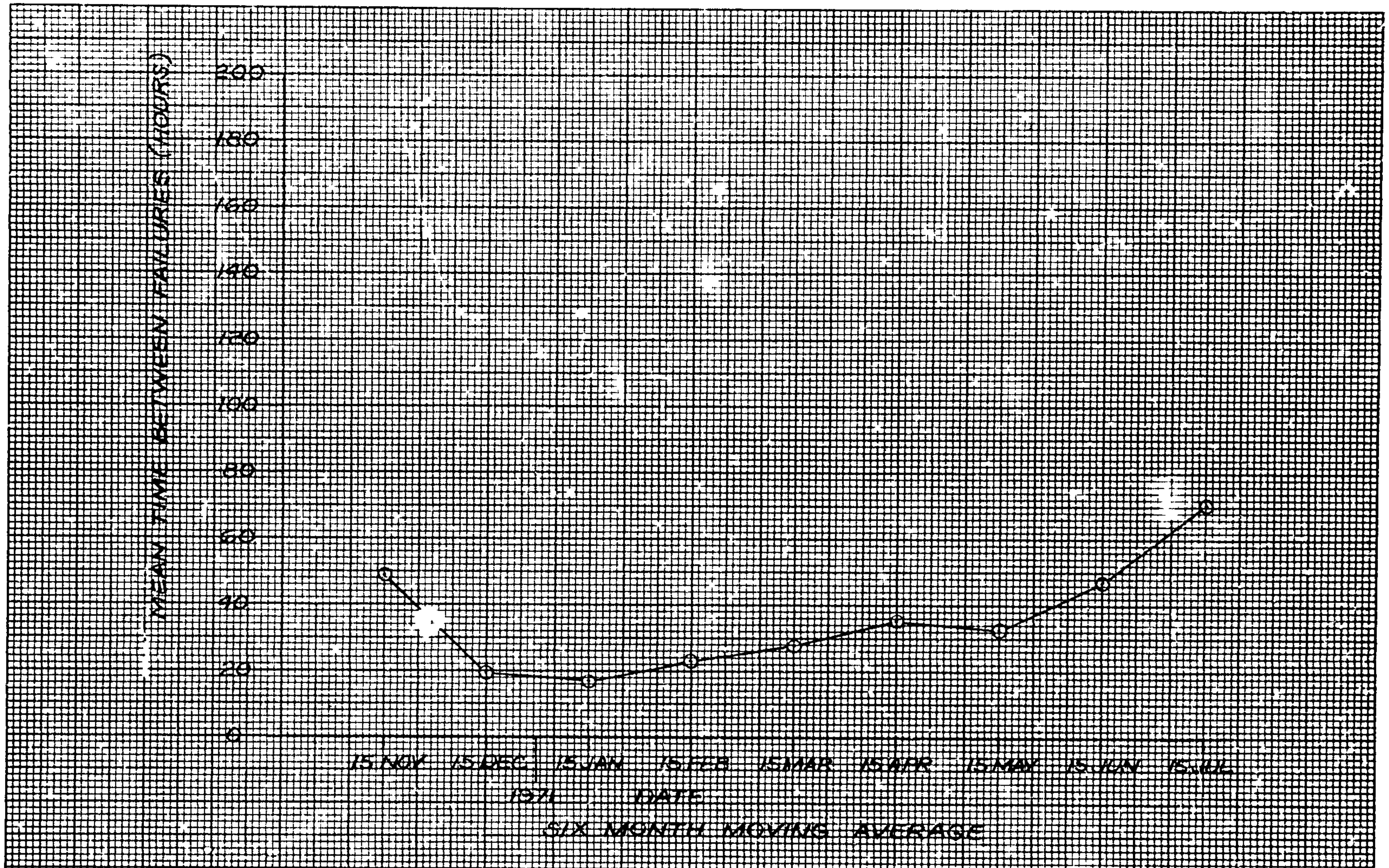


FIGURE 22. MEAN TIME BETWEEN FAILURES - TURBSHAFT POWERPLANT

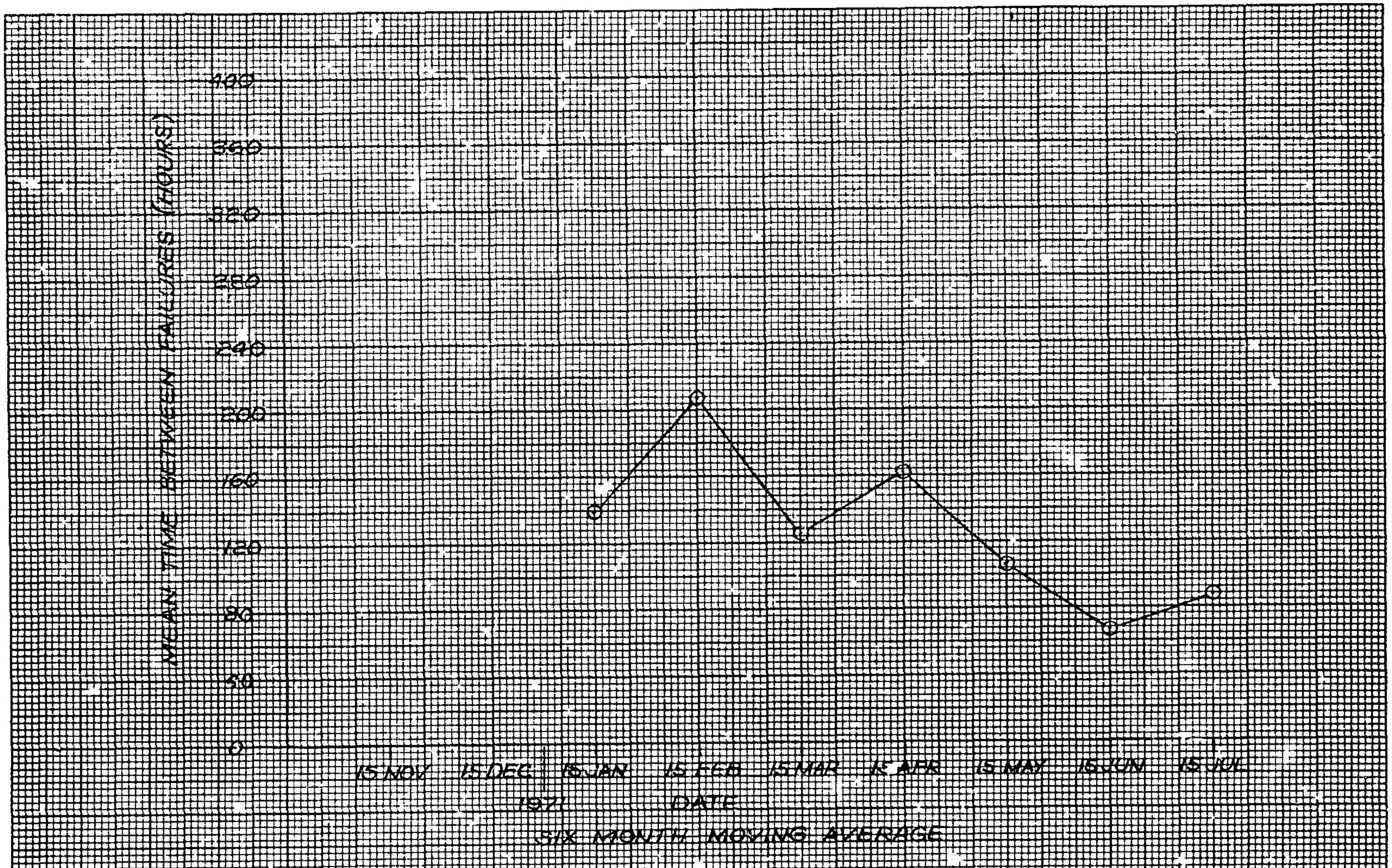


FIGURE 2-3 MEAN TIME BETWEEN FAILURES - ROTARY WING DRIVE SYSTEM

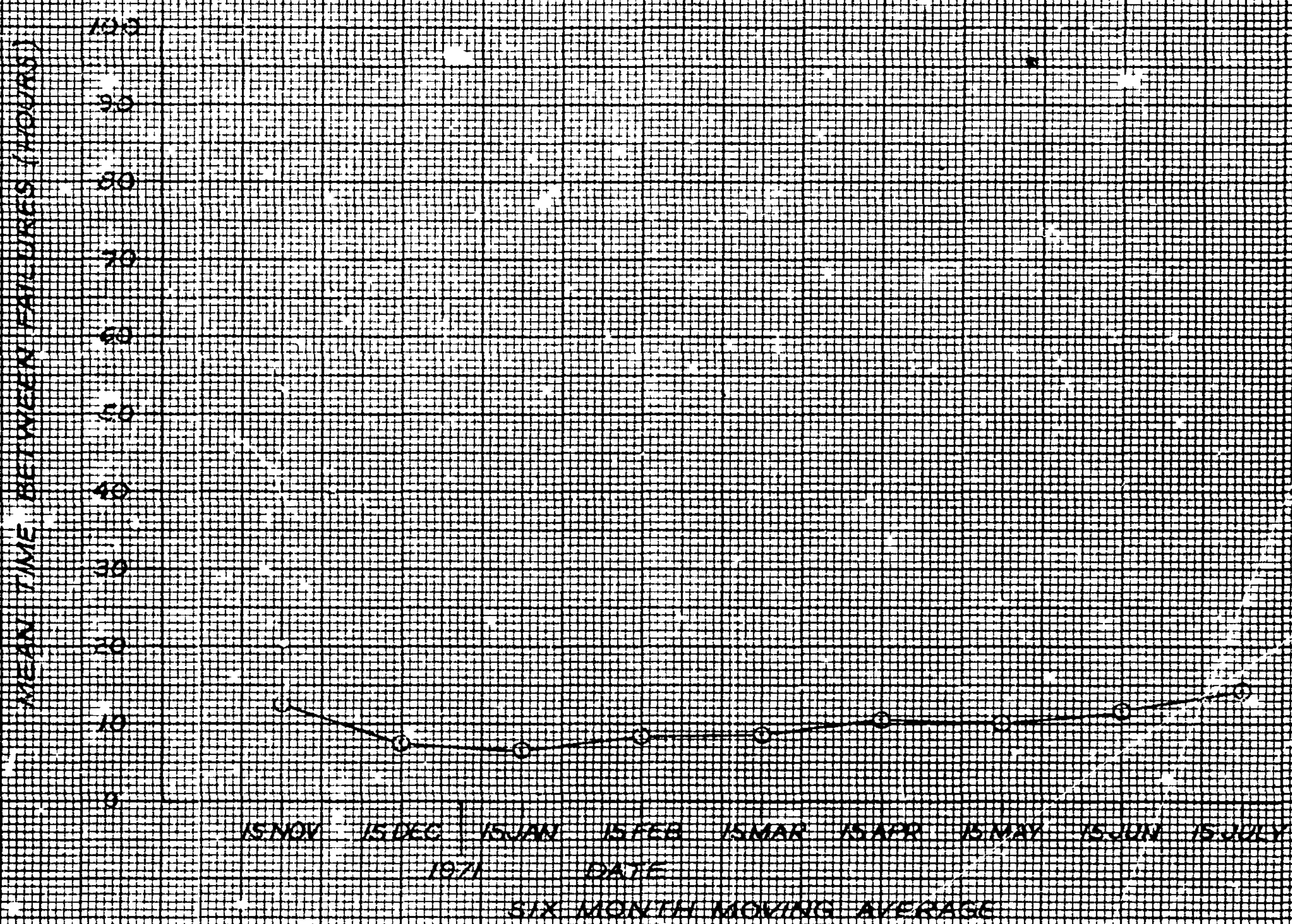


FIGURE C-4 MEAN TIME BETWEEN FAILURES - OVERALL AIRCRAFT

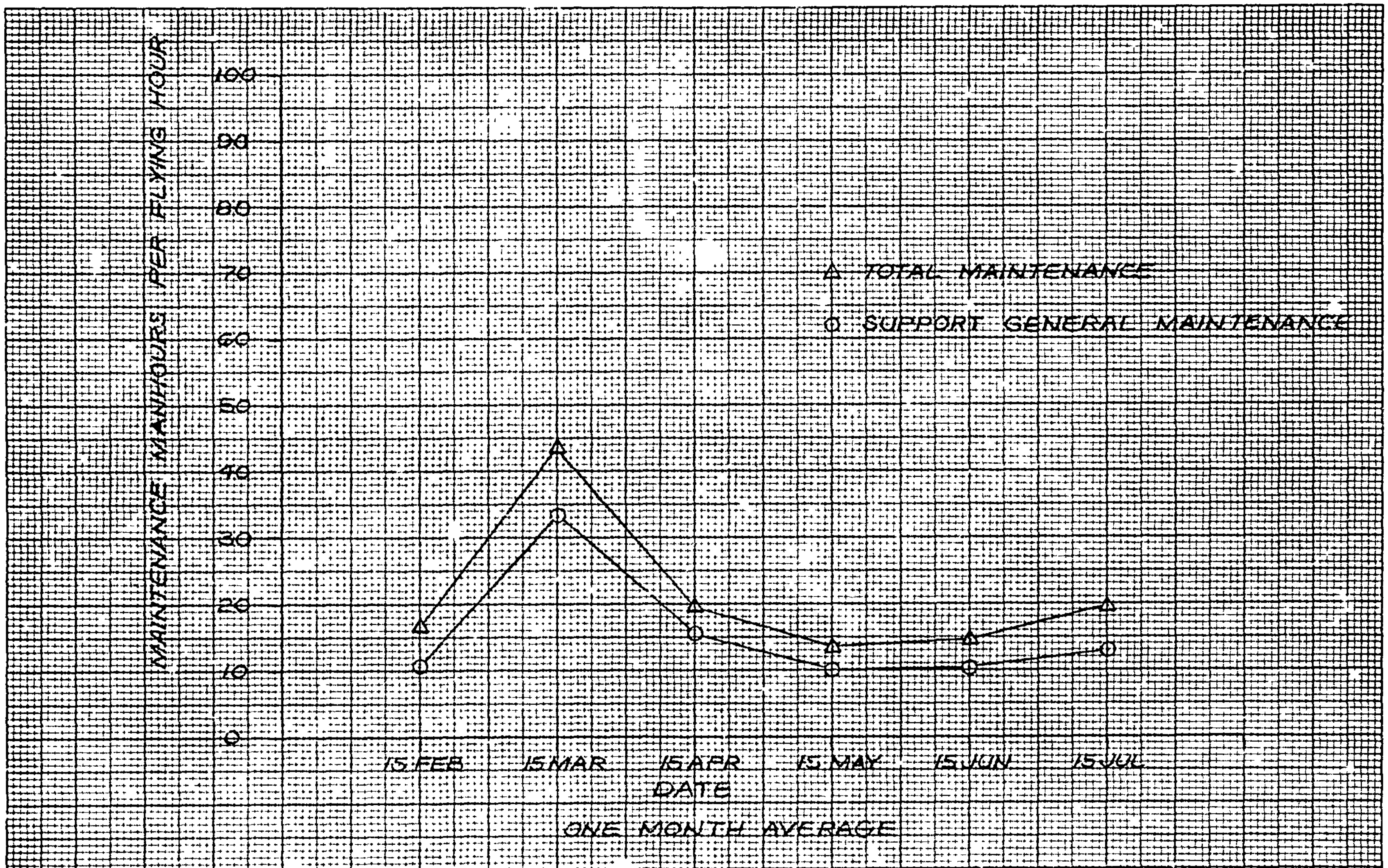


FIGURE 25 MAINTENANCE MANHOURS PER FLYING HOUR - OVERALL AIRCRAFT

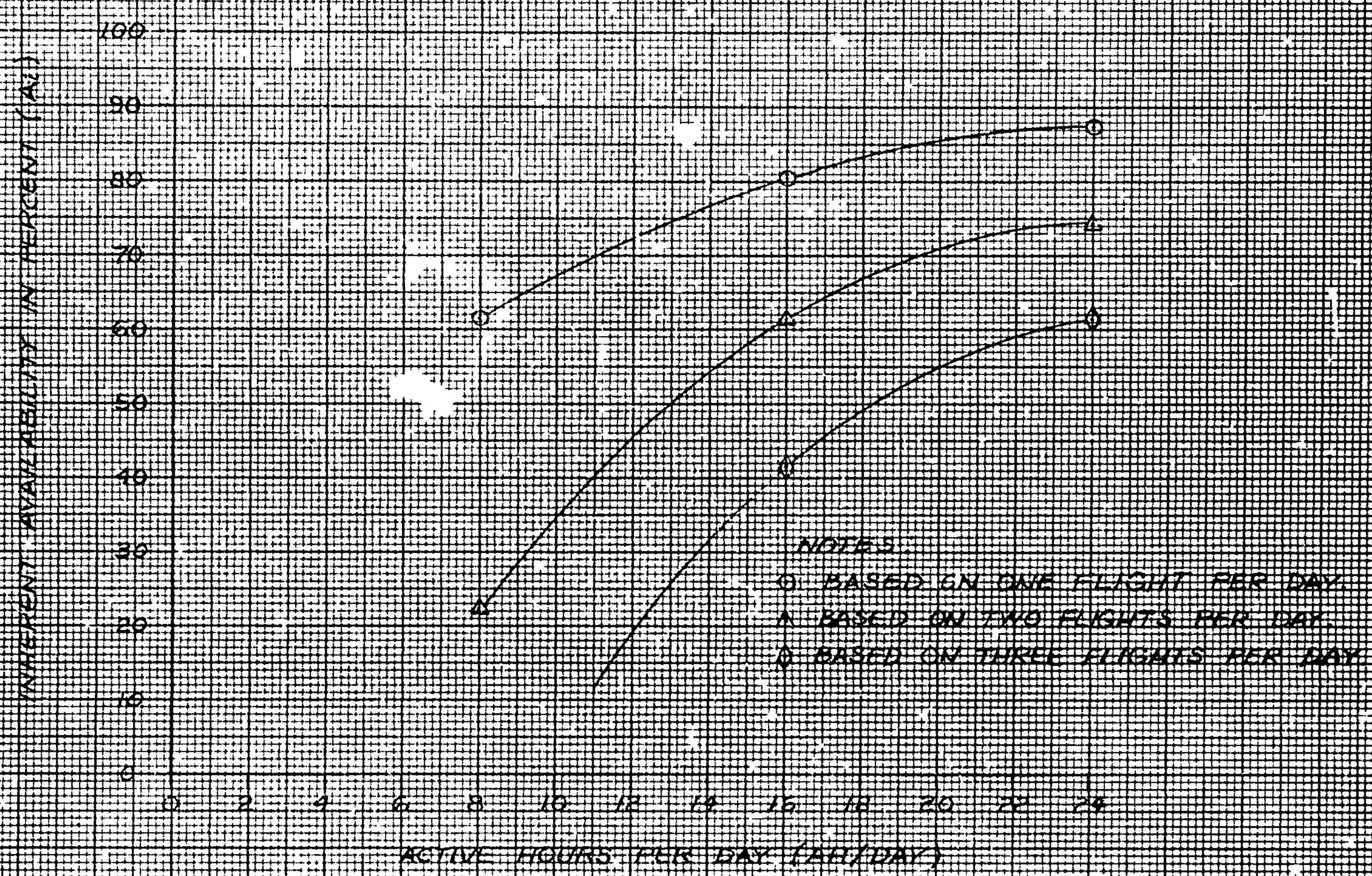


FIGURE 26 INHERENT AIRCRAFT AVAILABILITY

THIS PAGE LEFT BLANK FOR PRESENTATION PURPOSES

Form Approved
Budget Bureau No. 21–R251

10	A JOB CONTROL NUMBER	B PRI	C TIME SPEC REQD	D WORK AREA	E. ESTIMATED MANHOURS	F.	1 COPY NR 0	2. REPORT NUMBER № 084375
	3 BASIC WORK CENTER	4. ITEM IDENTIFICATION		5. SERIAL NUMBER	6. TIME/CYCLES MILES	7. WHEN DISCOVERED TIME *(Day-Mo-Yr-Hours)*	
	8 DATE THIS REPORT *(Day-Mo-Yr)*	9 WORK ORDER NUMBER		10. ORIG REPORT NUMBER	11. WHEN DISC CODE	12. ENG POSN NO	13. ACTIVITY IDENT

FAILED ITEM

20	14. MANUFACTURER	15. NOUN - ENGINE TYPE/MODEL/SERIES MOD		16. SERIAL NUMBER	17. TIME/CYCLES/MILES	18. PART NUMBER
	19. WORK UNIT CODE	20. SYMBOL	21. HOW MAL	22. FEDERAL SUPPLY CLASS	23.	24.

INSTALLED ITEM

30	25. MANUFACTURER	26. NOUN ENGINE TYPE MODEL/SERIES MOD	27. SERIAL NUMBER	28. TIME/CYCLES/MILES	29. PART NUMBER
40	G SUPPLY DOCUMENT NUMBER *(Issue or Demand)*	30. DESCRIPTION OF DISCREPANCY OR MAINTENANCE REQUIRED			
THRU					
49				H DISCOVERED BY	

	31. PRE FIX	AFSC	SUF	NR	32. START	33. STOP	34. DELAY CODE	35 START	36. STOP	37. DELAY CODE	38. WORK UNIT CODE	39. ASSISTING WORK CENTER	40. UNITS	41. ACT
50														
51														
52														
53														
54														
55														
56														
57														
58														
59														

60	42. T O. NUMBER	43. T.O DATE *(Day-Mo-Yr)*	44. T.O. PROCEDURE	45. TOOLS/AGE	I CORRECTED BY
61	46. CORRECTIVE ACTION				
THRU					
69					J. INSPECTED BY
	K SUPERVISOR	L. RECORDS ACTIONS ☐ UNCLEAR DISCREPANCY ☐ REPLACEMENT TIME CHANGE ☐ DATA TRANSCRIBED TO RECORDS		M. DATE TRANSCRIBED *(Day-Mo-Yr)*	N. TRANSCRIBED BY

AFSC FORM JAN 66 258 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. **MAINTENANCE DISCREPANCY/PRODUCTION CREDIT RECORD**

Figure 27 AFSC Form 258, Maintenance Discrepancy/Production Credit Record (front side)

	47. PIECE PARTS REPLACED DURING REPAIR									
	PART NUMBER	NOUN	WORK UNIT CODE	CIRCUIT SYMBOL	TYPE FAILURE		QTY	HOW MAL	MANUFACTURER	FSC
					PRI	SEC				
70										
T										
H										
R										
U										
79										

CODING TO BE IN BLOCKS AS INDICATED

BLOCK 34 AND 37 DELAY CODES

S AWAITING SUPPLIES AND/OR PARTS
C DELAY DUE TO CONFLICTING MAINTENANCE
A WORK STOPPAGE – NON-POWERED AGE OR RPIE
E WORK STOPPAGE – POWERED AGE OR RPIE
F FLYING
P AWAITING PERSONNEL ASSISTANCE
R ENGINE RUN-UP
T AWAITING TRANSPORTATION
X DELAY FOR WEATHER
K DELAY FOR SPECIAL TEST EQUIPMENT
M PREPLANNED MAINTENANCE DELAY

BLOCK 41 ACTION CODES

1. SERVICING
2. UNSCHEDULED MAINTENANCE
3. PREFLIGHT INSPECTION
4. POSTFLIGHT INSPECTION
5. HOURLY POSTFLIGHT
6. PERIODIC INSPECTION
7. SPECIAL INSPECTION
8. INDEPENDENT
9. RESEARCH AND DEVELOPMENT

BLOCK 44 T.O. PROCEDURE CODES

1. ADEQUATE
2. INADEQUATE
3. INCOMPLETE
4. MISIDENTIFIED
5. NOT AVAILABLE
6. INCORRECT INFORMATION
7. OTHER

BLOCK 45 TOOLS/AGE CODES

1. TOOLS ADEQUATE
2. TOOLS INADEQUATE
3. TOOLS NOT AVAILABLE
4. TEST EQUIPMENT ADEQUATE
5. TEST EQUIPMENT INADEQUATE
6. TEST EQUIPMENT NOT AVAILABLE
7. TOOLS AND TEST EQUIPMENT ADEQUATE
8. TOOLS AND TEST EQUIPMENT INADEQUATE
9. TOOLS AND TEST EQUIPMENT NOT AVAILABLE

* GPO 1966 O—799-591

AFSC (AAFB)

Figure 27 AFSC Form 258, Maintenance Discrepancy/Production Credit Record (concluded) (back side)

AIRCRAFT DEBRIEFING RECORD									TYPE
CARD NO.	1. AIRCRAFT TYPE	2. ID SERIAL NO.	3. MISSION NO.	4. DATE DAY MONTH YEAR	5. T.O. TIME HOURS MIN	6. DURATION HOURS MIN	7. TYPE MISSION	8. MSN EFFECT	9. LAND-INGS
1	U H 1 N A								
	10. GROSS WT (1000 LBS)	11. AUTO ROTATION LANDINGS	12. MINIGUN ROUNDS (1000)	13 GRE-NADES LAUNCHED	14. ROCKETS FIRED	15. ENGINE STARTS	16. BATTERY STARTS	17. ROTOR BRAKE APPLICATIONS	MINI-GUN JAMS
	18. PILOT	19. CO-PILOT	20.						

CARD NO.	BLOCK NO.	REL CODE	SYSTEM NAME	CARD NO.	BLOCK NO.	REL CODE	SYSTEM NAME
2	21		Airframe	2	51		
	22		Fuselage Compartment		52		
	23		Landing Gear		53		Radar NAV (Radar Altimeter)
	24		Flight Control		54		
	25		Rotor Systems		55		XM60 Sight
	26		Turbo Shaft Powerplant		56		M-93 Weapon
	27		Rotary Wing Drive System		57		M-25 Weapon
	28		Air Conditioning & Pressurization		58		Rocket Launcher
	29		Electrical Power		59		Grenade Launcher
	30		Lighting System		60		
	31		Hydraulic Power		61		External Stores Rack
	32		Fuel System		62		Ground Handling Kit
	33				63		Cargo Hook
	34				64		Rescue Hoist
	35		Misc Utilities (Fire Detection)		65		
	36				66		
	37		Instruments		67		
	38		VHF AM Communications		68		
	39		VHF FM Communications		69		Emergency Equipment
	40		HF Communications		70		
	41		UHF Communications		71		
	42		Interphone		72		
	43		IFF		73		
	44		Misc Communications (Loudspeaker)		74		Instrumentation
	45		TACAN		75		
	46		VOR		76		
	47		UHF Direction Finder		77		
	48		ADF		78		
	49		Marker Beacon		79		
	50				80		

MISSION OBJECTIVES	% SUCCESS

☐ I DO ☐ I DO NOT CONSIDER THE SYSTEM ADEQUATE TO PROCEED ON NEXT ASSIGNED MISSION.

SIGNATURE OF AIRCRAFT COMMANDER	SIGNATURE OF DEBRIEFER

CODE FOR BLOCKS AS INDICATED

BLOCK 7 (TYPE MISSION)	BLOCK 8 (MISSION EFFECTIVENESS)	RELIABILITY CODES
01 TRANSITION OR TRAINING	1. FLOWN AS BRIEFED	BLANK EQUIPMENT NOT USED
02 TEST SUPPORT	2. MISSION DEVIATION	1 OPERATED SATISFACTORILY
03 OTHER SUPPORT	3. AIR ABORT	2 DEGRADED OPERATION
04 SYSTEM TEST	4. GROUND ABORT	3 FAILED BUT NO ABORT
05 PERFORMANCE TEST	5. FLOWN AS BRIEFED & ADDITIONAL EVALUATION PERFORMED	4 FAILED AND ABORT
	NOTE: MISSIONS CHANGED FOR OTHER THAN MAINTENANCE ARE CODED 1.	5. FLOWN WITH KNOWN DISCREPANCY

AFFTC FORM AUG 68 0-294 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE.

Figure 28 AFFTC Form 0-294, Aircraft Debriefing Record (front side)

DISCREPANCIES [1]

CARD	BLOCK	REL CODE	JOB CONTROL NUMBER	WHEN DISC	WORK UNIT CODE	HOW MAL	ACTION	POSITION	BITE	SAFETY CODE	TIME TO FAIL HRS, MIN	
3												
DESCRIPTION OF DISCREPANCY												
CARD	BLOCK	REL CODE	JOB CONTROL NUMBER	WHEN DISC	WORK UNIT CODE	HOW MAL	ACTION	POSITION	BITE	SAFETY CODE	TIME TO FAIL HRS, MIN	
3												
DESCRIPTION OF DISCREPANCY												
CARD	BLOCK	REL CODE	JOB CONTROL NUMBER	WHEN DISC	WORK UNIT CODE	HOW MAL	ACTION	POSITION	BITE	SAFETY CODE	TIME TO FAIL HRS, MIN	
3												
DESCRIPTION OF DISCREPANCY												
CARD	BLOCK	REL CODE	JOB CONTROL NUMBER	WHEN DISC	WORK UNIT CODE	HOW MAL	ACTION	POSITION	BITE	SAFETY CODE	TIME TO FAIL HRS, MIN	
3												
DESCRIPTION OF DISCREPANCY												
CARD	BLOCK	REL CODE	JOB CONTROL NUMBER	WHEN DISC	WORK UNIT CODE	HOW MAL	ACTION	POSITION	BITE	SAFETY CODE	TIME TO FAIL HRS, MIN	
3												
DESCRIPTION OF DISCREPANCY												
CARD	BLOCK	REL CODE	JOB CONTROL NUMBER	WHEN DISC	WORK UNIT CODE	HOW MAL	ACTION	POSITION	BITE	SAFETY CODE	TIME TO FAIL HRS, MIN	
3												
DESCRIPTION OF DISCREPANCY												
CARD	BLOCK	REL CODE	JOB CONTROL NUMBER	WHEN DISC	WORK UNIT CODE	HOW MAL	ACTION	POSITION	BITE	SAFETY CODE	TIME TO FAIL HRS, MIN	
3												
DESCRIPTION OF DISCREPANCY												
CARD	BLOCK	REL CODE	JOB CONTROL NUMBER	WHEN DISC	WORK UNIT CODE	HOW MAL	ACTION	POSITION	BITE	SAFETY CODE	TIME TO FAIL HRS, MIN	
3												
DESCRIPTION OF DISCREPANCY												

[1] *NOTE:*

a *Obtain Block Number from front of this form.*

b *Obtain Job Control Number, When Discovered Code, Work Unit Code, How Malfunctioned Code, and Action Taken Code from AFSC Form 258/AFTO Form 349 as applicable, which shows the primary cause of failure.*

Figure 28 AFFTC Form 0-294, Aircraft Debriefing Record (concluded) (back side)

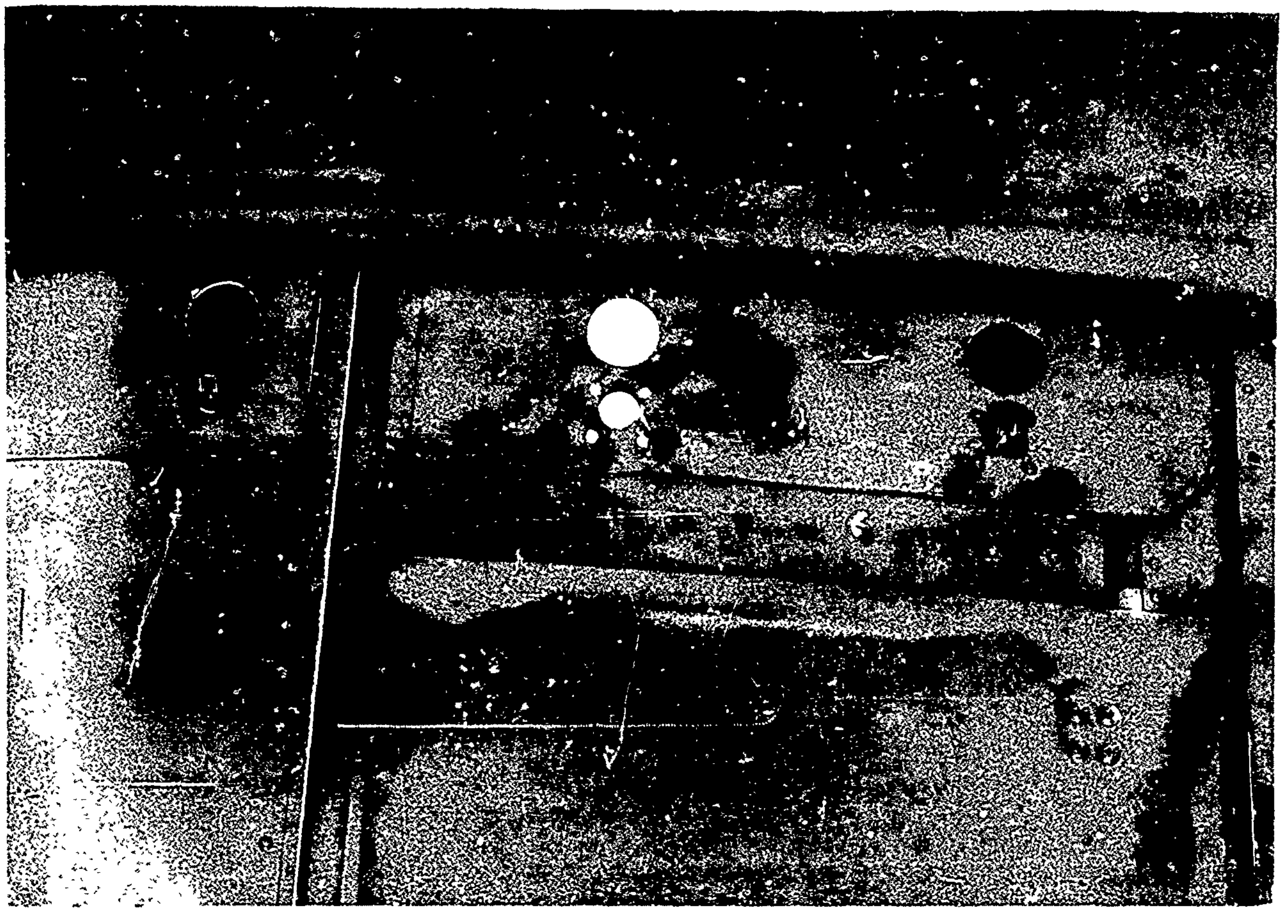


Figure 29 Cargo Door/Panel Latch Interference

Figure 30 Natural Response in Using Post Ladder

Figure 31   Natural Response in Using Post Ladder

2

Figure 32 Natural Response in Using Post Ladder

Figure 33 Natural Response in Using Post Ladder

Figure 34 Correct but Awkward Method of Using Post Ladder

Figure 35 Correct but Awkward Method of Using Post Ladder

Figure 36 Correct but Awkward Method of Using Post Ladder

Figure 37 Correct but Awkward Method of Using Post Ladder

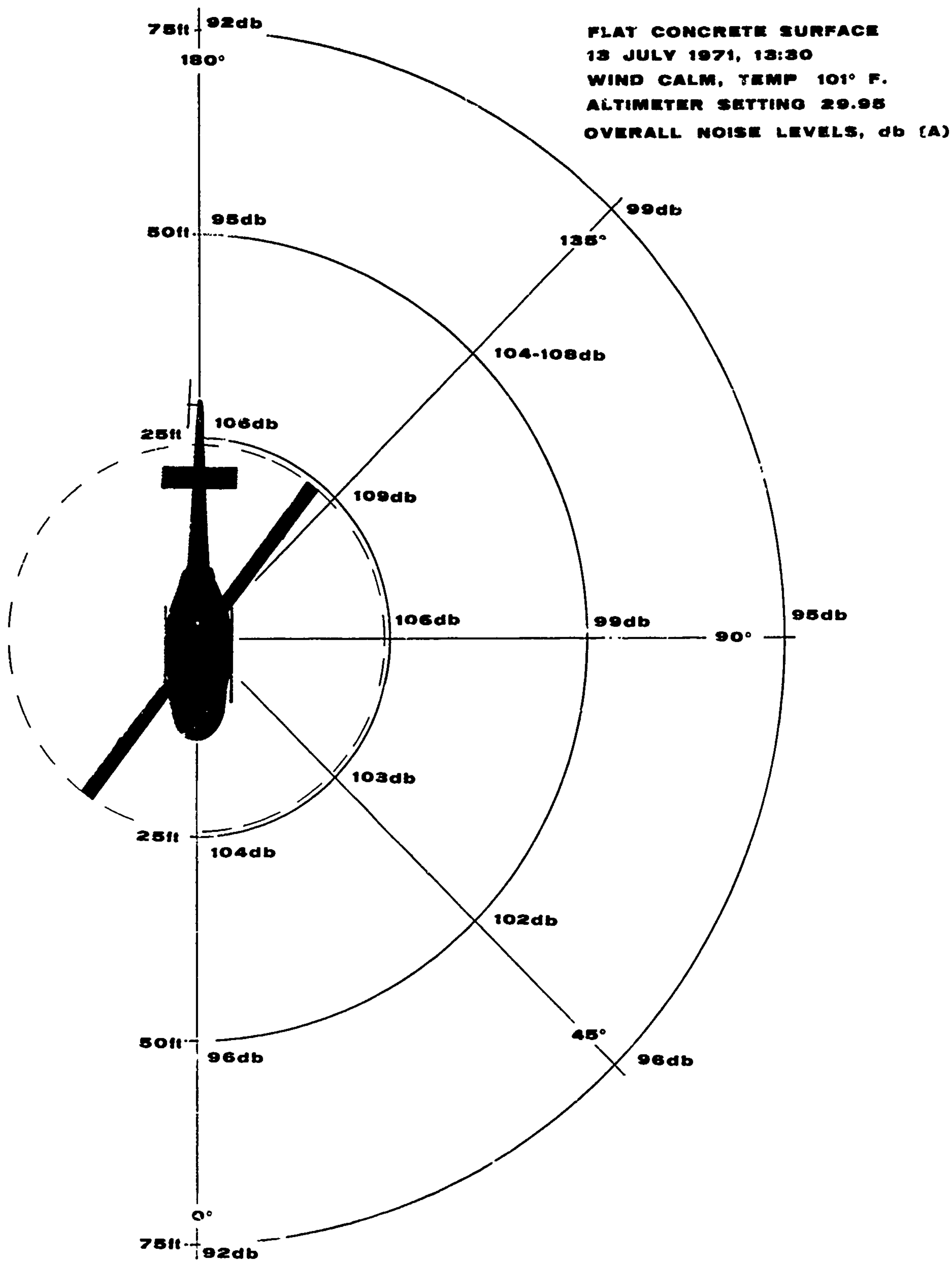


Figure 38 External Aircraft Noise Levels, Low Hover

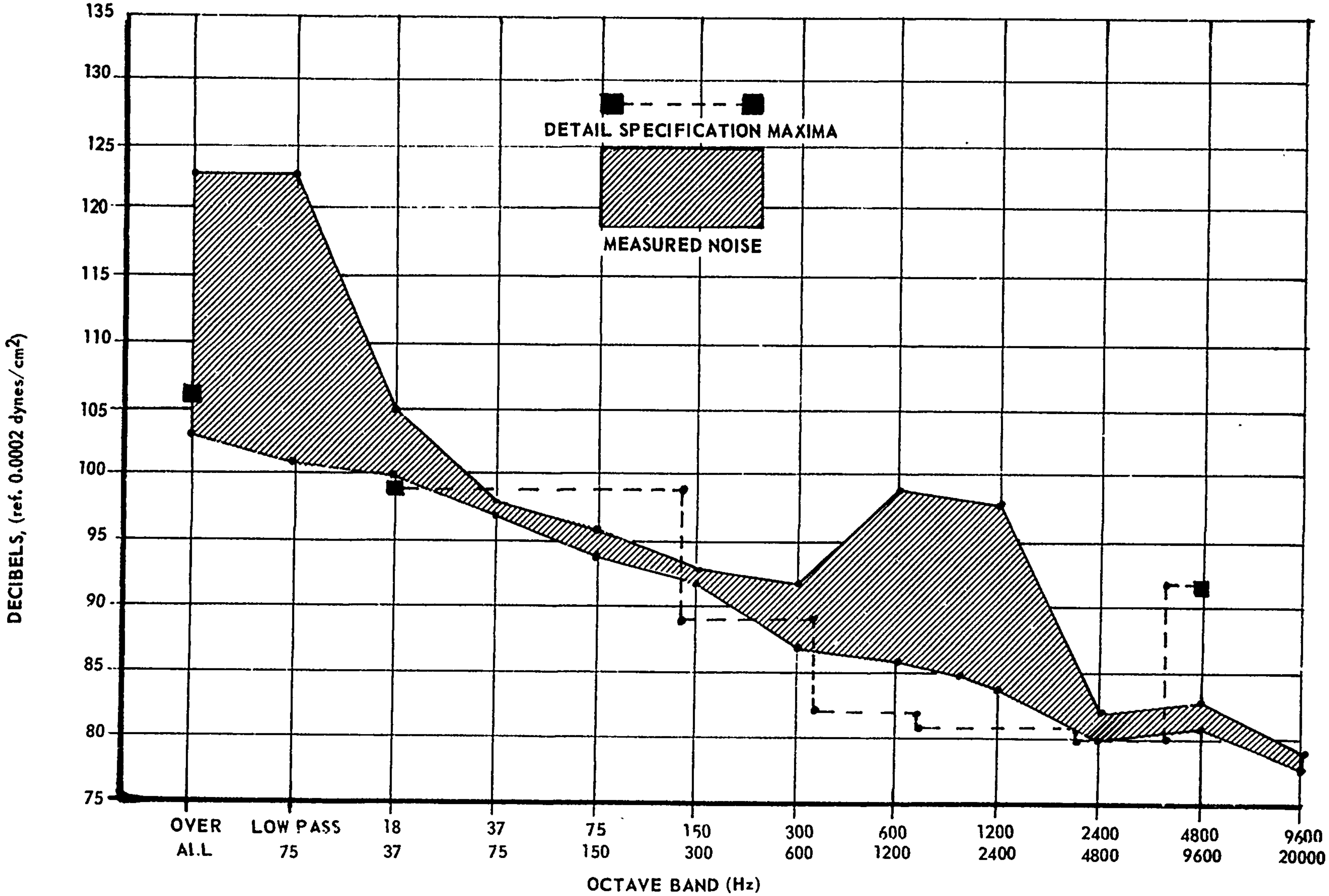


Figure 39 Comparison of Measured and Specified Noise Levels. Hover Operations

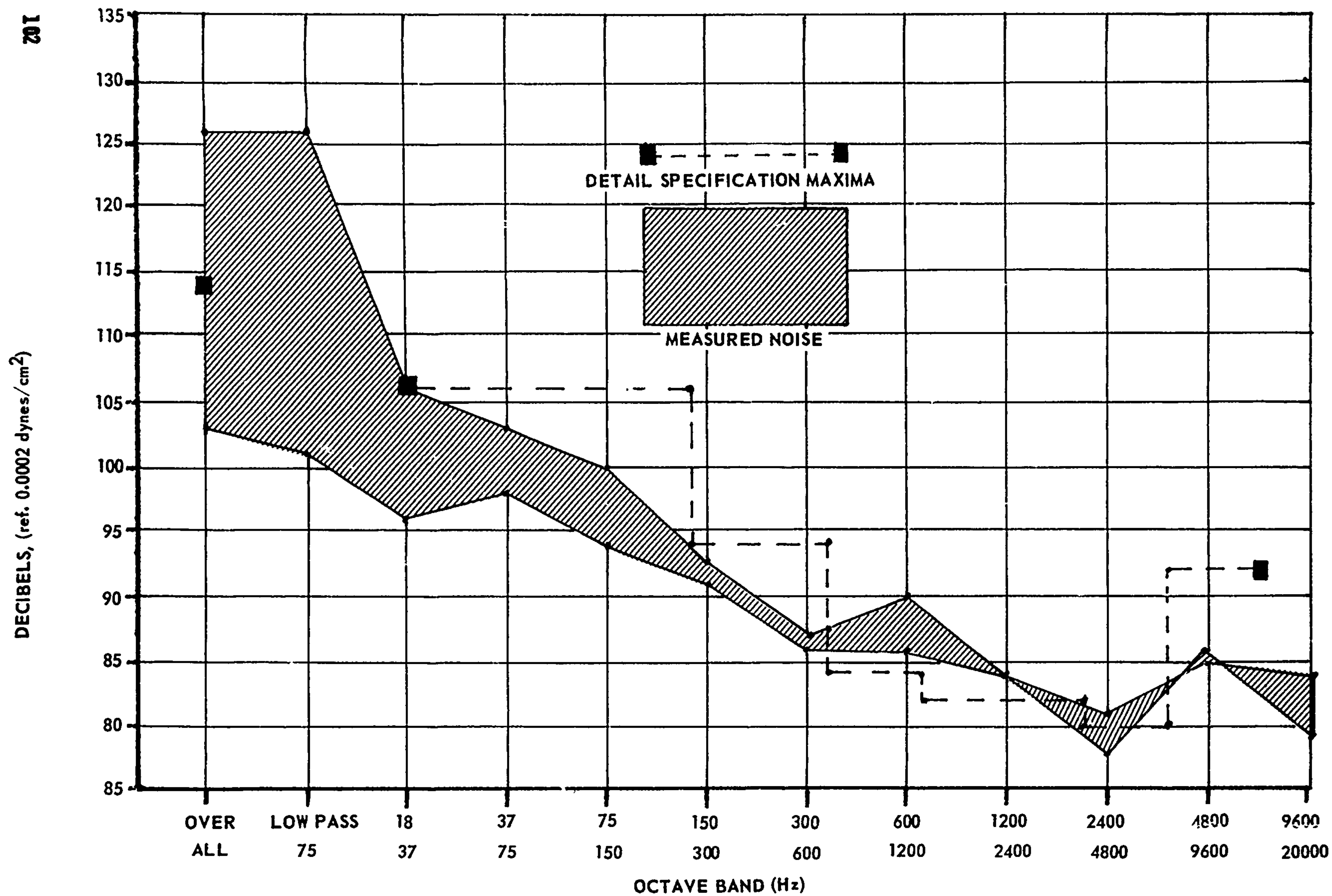


Figure 40 Comparison of Measured and Specified Noise Levels, 90-Knot Cruise

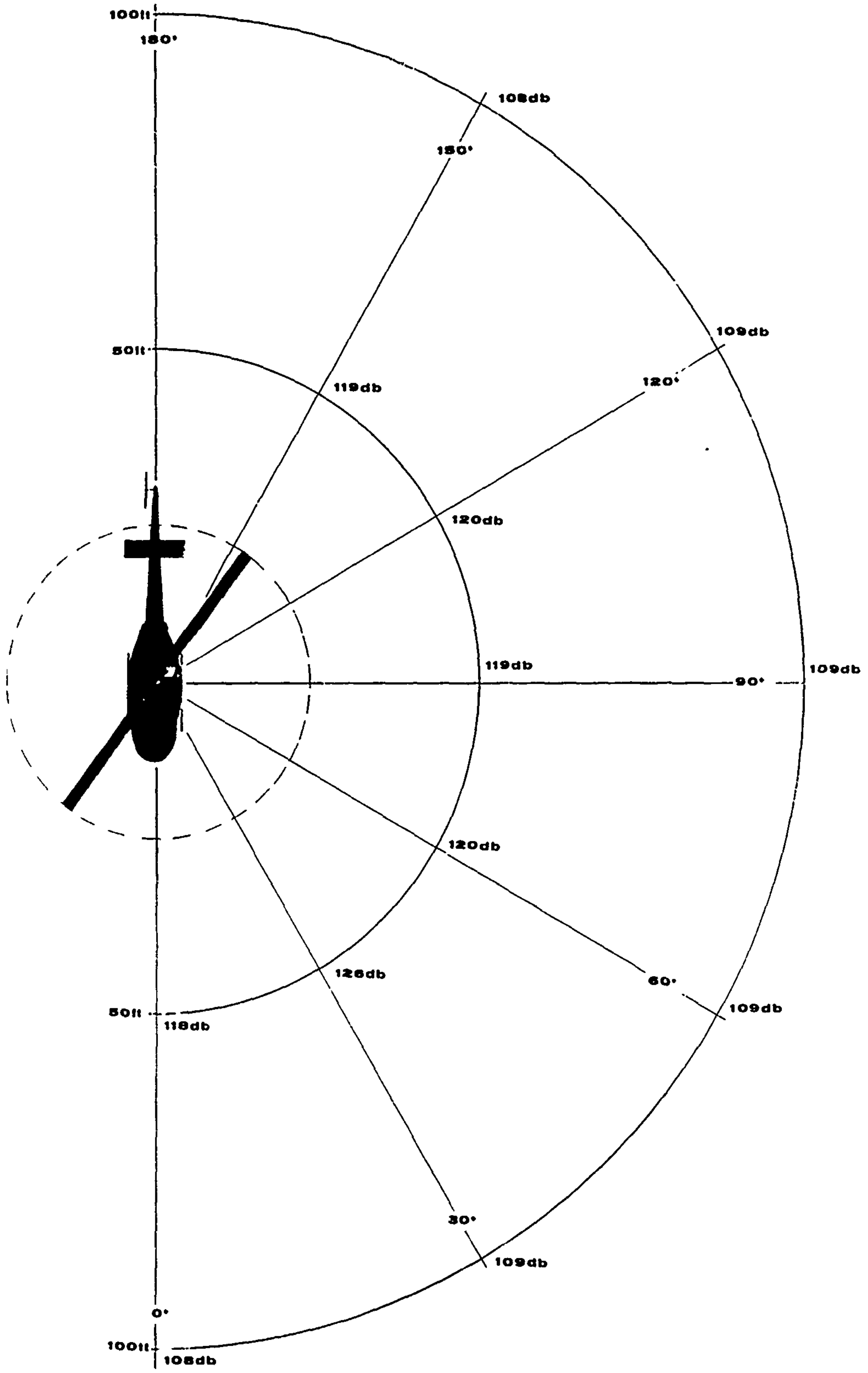


Figure 41 Loudspeaker Acoustical Energy Radiation Pattern

Table I

HOIST TEST OPERATIONS

(All hoist operations performed using 250-pound cable load.)

Lift-Lower Cycle No.	Lower Time (Minutes)	Raise Time (Minutes)
Lift Height: 14 feet		
1	0.2	0.2
2	0.2	0.2
3	0.2	0.2
4	0.2	0.2
Lift Height: 210 feet		
5	2.5	2.8
6	Not Recorded	2.7
7	2.8	2.8
8	3.0	Not Recorded

Temperatures at end of test:

Gearbox: 190 to 222 degrees F

Motor: under 190 degrees F

Total hoist energy developed: 448,000 foot-pounds

Elapsed time for test: 0.7 hour

Table II

PRE-ECP POWER OUTPUT AND REFLECTED POWER TESTS,
AN/ARC-115 VHF-AM AND AN/ARC-116 UHF-AM
(Acft S/N 69-6610, 1 Feb 1971)

Frequency (mHz)	Power Output at RT (watts)	Reflected at RT (watts)	At Antenna (watts)	Reflected at Antenna (watts)	VSWR at Antenna
AN/ARC-115 VHF-AM					
116.025	7.50	1.00	5.50	1.00	2.5
120.000	9.00	1.00	8.00	1.50	2.5
121.500	7.00	1.50	5.50	1.00	2.5
126.025	6.00	1.50	4.50	1.50	3.8
130.000	5.50	2.00	4.00	1.50	4.2
136.025	7.50	1.00	5.50	1.50	2.5
140.000	5.50	1.25	4.50	1.25	3.2
143.675	7.50	1.00	4.50	0.75	3.8
146.025	6.00	0.50	5.50	0.75	2.2
149.975	9.50	0.00	6.50	0.25	1.5
AN/ARC-116 UHF-AM					
225.000	12.50	1.50	7.00	1.75	3.0
242.000	11.50	1.00	5.00	1.00	2.6
259.000	12.50	0.00	5.50	1.00	2.5
276.000	14.00	1.00	6.50	1.00	2.3
293.000	13.00	0.50	6.00	0.50	1.8
310.000	13.50	0.50	5.50	0.75	2.2
327.000	14.50	1.00	5.50	0.00	1.0
344.000	10.50	0.50	5.75	0.50	2.3
361.000	13.00	0.50	4.50	0.50	2.0
383.000	10.00	1.50	3.75	0.50	2.2
399.900	9.50	0.50	4.50	0.50	2.0

Table III

PRE-ECP MAXIMUM RANGE TESTS, VHF AND UHF RECEIVER-TRANSMITTERS

Radio	Frequency (mHz)	Barometric Altitude Above the Ground Station (ft)	Observed Maximum Slant Range (NM) Inbound	Outbound	Required Range 85-pct Theoretical Radio Horizon (NM)
AN/ARC-115 VHF-AM	149.400	11,170	--	104.5	111
	149.400	9,670	96	---	103
AN/ARC-116 UHF-AM	304.000	2,500	--	33.0	52
	399.900	2,500	42	---	52

Table IV

POST-ECP POWER OUTPUT AND REFLECTED POWER TEST, AN/ARC-115 VHF-AM

Frequency (mHz)	Power at RT (watts)	Reflected at RT (watts)	Power at Antenna (watts)	Reflected at Antenna (watts)	VSWR at Antenna
116.025	12.50	0.25	11.25	0.50	1.5
120.000	10.00	1.25	7.00	1.00	2.2
121.500	9.00	1.25	8.00	1.00	2.1
126.025	11.50	1.00	9.00	0.75	1.8
130.000	10.00	0.50	9.75	0.50	1.6
136.025	9.00	0.75	10.00	0.50	1.6
140.000	12.00	0.25	7.50	0.25	1.5
143.675	11.00	0.00	8.00	0.25	1.4
146.025	11.00	0.00	10.00	0.00	1.0
149.975	11.00	0.25	8.50	0.00	1.0

Table V

POST-ECP PERCENTAGE INCREASE IN POWER, AN/ARC-115 VHF-AM
(at antenna)

Frequency (mHz)	Increase (pct)
116.025	104
120.000	-18*
121.500	45
126.025	100
130.000	143
136.025	81
140.000	66
143.675	77
146.025	81
149.975	30
Average Increase in Power Output = 61	

*This result can be attributed to a non-resonant antenna at this frequency.

Table VI

POST-ECP POWER OUTPUT AND REFLECTED POWER TEST,
AN/ARC-116 UHF-AM

Frequency (mHz)	Power at RT (watts)	Reflected at RT (watts)	Power at Antenna (watts)	Reflected at Antenna (watts)	VSWR at Antenna
225.00	8.00	0.50	7.50	0.00	1.0
242.00	11.00	0.50	6.00	0.00	1.0
259.00	9.50	0.50	8.50	0.00	1.0
276.00	9.00	0.50	7.00	0.50	1.7
293.00	8.25	0.50	8.00	0.00	1.0
310.00	9.50	0.00	7.00	0.50	1.7
327.00	8.00	0.50	7.50	0.00	1.0
344.00	7.00	0.75	6.50	0.50	1.8
361.00	7.50	0.50	7.00	0.50	1.7
383.00	6.00	0.75	8.50	0.50	1.6
399.95	8.50	0.50	5.00	0.50	1.9

Table VII

POST-ECP PERCENTAGE INCREASE IN POWER, AN/ARC-116 UHF-AM
(at antenna)

Frequency (mHz)	Increase (pct)
225.000	7
242.000	20
259.000	54
276.000	7
293.000	33
300.000	27
327.000	36
344.000	13
361.000	55
383.000	126
399.900	11
Average Increase in Power Output = 35	

Table VIII

POST-ECP MAXIMUM RANGE TEST, AN/ARC-115 VHF-AM

Frequency (mHz)	800 Feet AGL (NM)	1,200 Feet AGL (NM)	1,700 Feet AGL (NM)	2,500 Feet AGL (NM)
124.05	28	28	32	35
135.05	25	31	33	39
141.55	20	30	34	38

Table IX

POST-ECP MAXIMUM RANGE TEST, AN/ARC-116 UHF-AM

Frequency (mHz)	800 Feet AGL (NM)	1,200 Feet AGL (NM)	1,700 Feet AGL (NM)	2,500 Feet AGL (NM)
260.7	37	40	43	49
304.0	19	26	29	30
378.1	34	39	41	48

Table X

POWER OUTPUT AND REFLECTED POWER TESTS,
AN/ARC-114 VHF-FM
(Acft 69-6610, 2 Aug 1971)

Frequency (mHz)	Power at RT (watts)	Reflected at RT (watts)	Power at Antenna (watts)	Reflected at Antenna (watts)	VSWR at Antenna
30.00	22.00	2.00	9.50	2.25	2.9
35.00	18.00	2.00	10.50	3.00	3.3
40.00	14.00	1.75	10.50	2.00	2.6
45.00	18.00	1.75	12.00	2.50	2.7
50.00	16.50	2.00	10.00	2.00	2.6
55.00	15.00	1.75	7.50	2.00	3.1
60.00	17.50	1.50	7.25	1.50	2.7
65.00	19.00	0.00	12.00	1.00	1.8
0.00	21.50	1.00	11.50	1.25	1.4
75.95	15.50	1.00	9.50	1.25	2.1

Table XI

MAXIMUM RANGE TEST, AN/ARC-114 VHF-FM
(Acft S/N 69-6610, 9 Jul 1971)

Frequency (mHz)	800 Feet AGL (NM)	1,200 Feet AGL (NM)	1,700 Feet AGL (NM)	2,500 Feet AGL (NM)
34.95	38	41	*	*
49.95	31	39	41	51
75.75	15	22	27	32

*Test could not be continued due to terrain interference.

Table XII

GYROMAGNETIC COMPASS ACCURACY TEST, Acft S/N 68-10774
(Ground Test)

Actual Magnetic Heading (deg)	Indicated Magnetic Heading (deg)	Deviation (deg)
001	001	0
047	046	+1
091	091	0
136	136	0
181	181	0
225	225	0
270	270	0
316	316	0

Table XIII

DG DRIFT RATE TEST, GYROMAGNETIC COMPASS DATA

Mission Duration (hrs)	Total Drift (deg)	Drift Per Hr (deg)	Mission
2.00	3	1.5	Weapons Delivery Test
1.33	2	1.5	Hoist Test
1.54	5	3.2	ADF Homing Test
1.06	2	1.8	Maximum Range Communication Test

Table XIV

AQU-5A MAGNETIC COMPASS ACCURACY - XM60 SIGHT NOT INSTALLED
(Acft S/N 68-10774)

Actual Heading (deg) (Kollsman B-16)	Indicated Heading (deg)	Card-Corrected Heading (deg)	Deviation (deg)
001	005	005	+4
047	048	048	+1
091	087	087	-4
136	130	130	-6
181	178	182	+1
225	228	230	+5
270	276	280	+10
316	322	325	+9

Table XV

AQU-5A MAGNETIC COMPASS ACCURACY - XM60 SIGHT NOT INSTALLED
(Acft S/N 69-6610)

Actual Heading (deg) (Kollsman B-16)	Indicated Heading (deg)	Card-Corrected Heading (deg)	Deviation (deg)
005	003	003	-2
045	046	046	+1
096	088	088	-8
138	132	132	-6
176	179	179	+3
220	232	233	+13
266	274	276	+10
317	318	319	+2

Table XVI

AQU-5A MAGNETIC COMPASS ACCURACY - WITH XM60 SIGHT INSTALLED
(Acft S/N 69-6610)

Actual Heading (deg) (Kollsman B-16)	Indicated Heading (deg)	Card Corrected Heading (deg)	Deviation (deg)
002	005	005	+3
054	051	051	+3
096	092	092	+4
138	135	135	+3
174	179	179	+5
219	225	226	+7
266	269	271	+5
317	317	318	+1

Table XVII

UHF DIRECTION FINDER ACCURACY

Test Station Frequency (mHz)	Average Error (deg)	RMS Error Value (deg)	Required RMS Value (deg)
UHF BCN China Lake NAF 265.2	+3.66	+8.63	±7.00
FCA Van 304.0	+2.83	±8.08	±7.00
FCA Van 378.1	+3.42	±9.76	±7.00

Table XVIII

TACAN ACCURACY

Station	Radial Error* (deg)	Distance Error* (NM)	Average Distance to Station (NM)
Lake Hughes Vortac Channel 21	1.25	0.36	37
George AFB Tacan Channel 43	0.55	0.40	37
China Lake NAF Tacan Channel 53	1.90	0.55	59
Edwards AFB Tacan Channel 68	1.82	0.53	17
Daggett Vortac Channel 79	1.00	0.25	62
Palmdale Vortac Channel 92	1.83	0.25	19
Gorman Vortac Channel 108	2.41	0.31	50

*Averages of the absolute value of 12 data points for each station.

Table XIX

TACAN MAXIMUM RANGE - RADIALS

Tacan Station Channel No.	Break Lock			Make Lock		
	Pressure Altitude (ft)	Inbound (NM)	Required* Range (NM)	Pressure Altitude (ft)	Outbound (NM)	Required* Range (NM)
Castle AFB 60	8,500	148	90	9,200	141	93
Fresno Vortac 76	4,800	102	69	5,400	104	70
Lemoore NAS 80	3,900	69	62	5,500	71	70
Avenal Vortac 118	1,400	46	34	2,700	49	49
Porterville Vortac 29	800	41	28	1,100	40	31
Bakersfield Vortac 101	200	22	14	200	21	14

*Eighty percent of maximum radio path distance assumed as reasonable requirement for altitudes below 10,000 feet.

Table XX

TACAN MAXIMUM RANGE - DME

Tacan Station Channel No.	Break Lock			Make Lock		
	Pressure Altitude (ft)	Inbound (NM)	Required Range (NM)	Pressure Altitude (ft)	Outbound (NM)	Required Range (NM)
Castle AFB 60	10,900	148	103	9,200		93
Fresno Vortac 76	5,400	102	73	5,400	104	73
Lemoore NAS 80	4,100	69	62	5,500	71	71
Avenal Vortac 118	4,300	45	45	2,700	49	50
Porterville Vortac 29	1,100	41	33	1,100	40	33
Bakersfield Vortac 101	200	22	14	200	20	14

Table XXI

ADF COMPENSATION DATA

Goniometer Indicated Heading (deg)	Pilot's BDHI (deg)	Pilot's BDHI Compensated* (deg)
015	015	021
045	046	056
075	075	082
105	105	104
135	135	129
165	165	161
195	195	197
225	225	229
255	252	258
285	282	283
315	314	308
345	344	343

*Compensation data for UH-1N aircraft obtained from reference 21.

Table XXII

ADF NAVIGATION FIX TEST

Station No. 1, KFI (mag deg)	Station No. 2, KVAR (mag deg)	Tacan		Difference: Tacan to ADF*	
		Radial (mag deg)	Distance (NM)	(NM)	(deg)
155	098	060	22.0	2	311
141	090	044	14.5	8	281
142	089	040	11.0	4	282

*These figures were derived from ADF and tacan data plotted graphically on navigational charts.

Table XXIII

VOR RADIAL ACCURACY TEST

VOR Station	Radial Error* (deg)	Average Distance To Station (NM)
Lake Hughes Vortac 108.4 mHz	1.27	36
Edwards AFB VOR 116.4 mHz	1.90	17
Daggett Vortac 113.2 mHz	1.50	62
Palmdale Vortac 114.5 mHz	1.75	19
Gorman Vortac 116.1 mHz	2.33	50

*Average of the absolute value of 12 data points.

Note: VOR bench test radial accuracy required was ± 0.7 degree (reference 22).

Table XXIV

VOR RECEIVER MAXIMUM RANGE TEST

Vor Station (mHz)	Break Lock			Make Lock		
	Pressure Altitude (ft)	Inbound (NM)	Required Range (NM)	Pressure Altitude (ft)	Outbound (NM)	Required Range (NM)
Merced VOR 114.2	7,500	137	83	8,900	130	90
Fresno Vortac 112.9	4,750	102	70	5,400	104	72
Visalia VOR 109.4	1,900	63	42	3,300	64	55
Porterville Vortac 109.2	1,500	42	40			
Bakersfield Vortac 115.4	200	22	14	300	22	14

Table XXV

RADAR ALTIMETER ACCURACY TEST

Measured Altitude (ft)	Radar Altimeter Indication* (ft)	Error Error (ft)	Error Limit** (ft)
10	10.0	+0.0	±5.8
20	23.3	+3.3	±5.8
50	50.0	+0.0	±5.8
100	104.0	-4.0	±5.8
200	197.4	-2.6	±6.7
300	295.4	-4.6	±9.4
500	491.0	-9.0	±15.3
1,000	975.7	-24.3	±30.2
2,000	1,953.0	-47.0	±60.1
3,000	2,929.7	-70.3	±90.1
4,000	3,970.7	-29.3	±120.0
5,000	4,988.0	-22.0	±150.0

*Average of three data points.

**Error limit was calculated from the specified radar altimeter accuracy of ±5 feet or ±3 percent of actual altitude, whichever was greater, and the measurement error of ±3 feet combined by the equation

$$\text{Error Limit} = A^2 + M^2$$

where

A = altimeter error

M = measurement error

Table XXVI

MARKER BEACON RECEIVER TEST

Altitude AGL (ft)	Receiver Sensitivity Switch Position	Distinct Tone Rec'd Before Station Passage (ft)	Distinct Tone Rec'd After Station Passage (ft)	Antenna Pattern Symmetry Ratio	Distinct Light Rec'd Before Station Passage (ft)	Distinct Light Rec'd After Station Passage (ft)	Antenna Pattern Symmetry Ratio
500	HIGH	1,500	2,060	0.78	1,030	1,730	0.56
	LOW	640	1,060	0.60	380	620	0.61
1,700	HIGH	4,000	3,320	1.20	2,740	2,900	0.94
5,000	HIGH	4,520	4,920	0.92	2,700	1,750	1.59
5,000*	HIGH	4,445	4,535	0.98	2,680	5,050	0.53
5,000	LOW	No Signal Received					

MIL-A-5999A requires that duration of marker beacon indication when approaching a marker beacon station be not more than 50 percent greater than the duration of marker beacon indications when leaving a marker beacon station. Therefore the Antenna Pattern Symmetry ratio shall be greater than 0.67 but less than 1.5.

*This pass made 2,000 feet north of runway centerline to check antenna pattern to the side of the aircraft.

Table XXVII

SUBSYSTEM MISSION MALFUNCTION REPORT
(16 Oct 1970 through 15 Jul 1971)

Subsystem	Success	Discrepancy	Fail	Abort	Time
Airframe	402	6	0	1	489.08
Fuselage Compartment	407	1	0	0	489.08
Landing Gear	408	0	0	0	489.08
Flight Control	399	8	1	1	489.08
Rotor Systems	318	89	0	1	489.08
Turbo Powerpla	374	25	6	7	489.08
Rotary Drive	400	4	2	3	489.08
Heat, Ventilation	408	0	0	0	489.08
Electrical Power	401	6	1	1	489.08
Lighting System	405	2	1	0	489.08
Hydraulic Power	406	1	1	0	489.08
Fuel System	405	2	1	1	489.08
Misc Utilities	408	0	0	0	489.08
Instruments	404	1	3	0	489.08
VHF-AM Communications	330	3	4	0	395.34
VHF-FM Communications	296	0	2	0	399.94
HF Communications	4	0	3	0	12.08
UHF Communications	373	3	4	0	464.41
Interphone	407	1	0	0	4[illegible]8
IFF	81	0	0	0	117.77
Misc Communications	3	0	0	0	4.25
Tacan	352	0	4	0	428.04
VOR	354	1	0	0	428.04
UHF Direction Finder	116	0	3	0	141.52
ADF	10	0	0	0	12.00
Marker Beacon	19	0	0	0	24.33
Radar Altimeter	8	0	0	0	14.58
XM60 Sight	89	0	0	0	99.77
M93 Weapon	15	0	0	0	26.98
Rocket Launcher	9	0	1	1	16.92
Grenade Launcher	10	2	0	0	20.08
Ext Stores Rack	19	0	0	0	32.80
Rescue Hoist	2	0	0	0	3.92

Table XXVIII

SUBSYSTEM MISSION RELIABILITY REPORT
(16 Oct 1970 through 15 July 1971)

Subsystem	Mean Time Between Discrepancy		Mean Time Between Failure		Mean Time Between Abort	
	Measured	90 Percent Lower Confidence Limit	Measured	90 Percent Lower Confidence Limit	Measured	90 Percent Lower Confidence Limit
Airframe	69.9	41.5	489.1	125.7	489.1	125.7
Fuselage Compartment	489.1	125.7	NO FAIL	212.4	NO ABORT	212.4
Landing Gear	NO DISC	212.4	NO FAIL	212.4	NO ABORT	212.4
Flight Control	48.9	31.8	244.5	91.9	489.1	125.7
Rotor Systems	5.4	4.7	489.1	125.7	489.1	125.7
Turbo Powerplant	12.9	10.4	37.6	25.8	69.9	41.5
Rotary Drive	54.3	34.4	97.8	52.7	163.0	73.2
Heat, Ventilation	NO DISC	212.4	NO FAIL	212.4	NO ABORT	212.4
Electrical Power	61.1	37.6	244.5	91.9	489.1	125.7
Lighting System	163.0	73.2	489.1	125.7	NO ABORT	212.4
Hydraulic Power	244.5	91.9	489.1	125.7	NO ABORT	212.4
Fuel System	122.3	61.2	244.5	91.9	489.1	125.7
Misc Utilities	NO DISC	212.4	NO FAIL	212.4	NO ABORT	212.4
Instruments	122.3	61.2	163.0	73.2	NO ABORT	212.4
VHF-AM Communications	56.5	33.6	98.8	49.5	NO ABORT	171.7
VHF-FM Communications	175.0	66.5	175.0	66.5	NO ABORT	152.0
HF Communications	4.0	1.5	4.0	1.5	NO ABORT	5.2
UHF Communications	66.3	39.5	116.1	58.1	NO ABORT	201.7
Interphone	489.1	125.7	NO FAIL	212.4	NO ABORT	212.4
IFF	NO DISC	51.1	NO FAIL	51.1	NO ABORT	51.1
Misc Communications	NO DISC	1.8	NO FAIL	1.8	NO ABORT	1.8
Tacan	107.0	53.5	107.0	53.5	NO ABORT	185.9
VOR	428.0	110.0	NO FAIL	185.9	NO ABORT	185.9
UHF Direction Finder	47.2	21.2	47.2	21.2	NO ABORT	61.5
ADF	NO DISC	5.2	NO FAIL	5.2	NO ABORT	5.2
Marker Beacon	NO DISC	10.6	NO FAIL	10.6	NO ABORT	10.6
Radar Altimeter	NO DISC	6.3	NO FAIL	6.3	NO ABORT	6.3
XM60 Sight	NO DISC	43.3	NO FAIL	43.3	NO ABORT	43.3
M93 Weapon	NO DISC	11.7	NO FAIL	11.7	NO ABORT	11.7
Rocket Launcher	8.5	3.2	8.5	3.2	16.9	4.4
Grenade Launcher	10.0	3.8	NO FAIL	8.7	NO ABORT	8.7
Ext Stores Rack	NO DISC	14.2	NO FAIL	14.2	NO ABORT	14.2
Rescue Hoist	NO DISC	1.7	NO FAIL	1.7	NO ABORT	1.7

Table XXIX

SUBSYSTEM HARDWARE RELIABILITY
(16 October 1970 through 15 July 1971)

WUC Subsystem	MTBF*	90 pct LCL	Comments
11000 Airframe	14.4	11.2	Numerous skin cracks and broken latches were discovered and repaired during phase inspections. AFFTC RUMR R70-904 concerning cracked engine inlet ducts was submitted and has been closed by the initiation of a TCTO.
12000 Fuselage Compartment	81.5	46.5	Torn and cracked interior materials were the major problems.
13000 Landing Gear	122.3	73.4	One aircraft had both crossover tubes, one skid, and one skid pad replaced.
14000 Flight Controls	44.4	24.3	Three failures of a bearing located in the anti-torque controls was the major problem. RUMR R71-79 was submitted for this problem and is still open. Additionally, there were failures of a tail rotor pitch control tube, collective servo boot, and tail rotor servo bushing. Frequent adjustments of the collective and cyclic controls were required.
15000 Rotor Systems	5.2	4.5	A delaminated blade and leaking main rotor hub assembly were the main problems. Numerous adjustments were required to track the main rotor blades properly after replacement.

*Based on 489.1 airframe hours.

Table XXIX (Continued)

WUC Subsystem	MTBF	90 pct LCL	Comments
22000 Turboshaft Powerplant	10.6	8.8	Three power sections were replaced due to internal failure. Topping power adjustments, throttle adjustments, and fuel control replacements were all problems.
26000 Rotary Wing Drive System	28.8	20.5	Blown transmission oil filter gaskets and false indication of high transmission oil temperatures were the major problems. RUMR's R71-261, R71-262, and R71-263 were submitted concerning the oil temperature problem and are still open.
42000 Electrical Power System	44.5	29.4	There were two failures of main inverters and three cases of generators dropping off the line. RUMR 24 SOWg R70-43 concerning the generator problem was submitted and is still open. See reference 5.
44000 Lighting System	163.0	73.4	Burned out light bulbs and incorrect wiring of an aircraft navigation light were the only problems.
45000 Hydraulic Power Supply	122.3	61.6	Replacements of an integrated valve and filter assembly and a pressure sensing switch were the main problems.
46000 Fuel System	69.9	41.6	There were two failures of boost pumps, one failure of a boost pump pressure switch, and several minor failures.

Table XXIX (Concluded)

WUC Subsystem	MTBF	90 pct LCL	Comments
51000 Instruments	69.9	41.6	There were three gyro failures, two attitude indicator failures, and two RMI amplifier failures.
61000 HF Communication	---	---	There were two failures of the radio set and a failure of an antenna coupler. Due to limited use, an MTBF statistic is not presented.
62100 VHF-FM Communications	489.1	125.5	Radio set replaced
62300 VHF-AM Communications	69.9	41.6	Seven radio sets were replaced.
63000 UHF Communications	163.0	73.4	Three radio sets were replaced.
71210 Tacan	122.3	61.6	Three receiver-transmitters were replaced along with an antenna.
71100 UHF Direction Finder	53.0	23.8	There were replacements of an antenna and two amplifiers.
75000 Weapon Delivery	38.2	9.85	Rocket launcher emergency jettison system required adjustment.

Table XXX

MAINTENANCE MANHOURS PER FLYING HOUR - BY WORK UNIT CODE
(16 Jan 1971 through 15 July 1971)

Title	WUC	MMH/FH	Percent of Total
Ground Handling, Service	1	4.0	21.0
Aircraft Cleaning	2	2.2	11.5
Look Phase of Inspection	3	6.3	33.4
Special Inspections	4	1.0	5.5
Aircraft and Engine Storage	5	0.0	0.0
Ground Safety	6	0.0	0.2
Preparation of Aircraft Records	7	0.1	0.3
Shop Support General	9	0.0	0.1
Totals for Support General		13.5	72.1
Corrective Maintenance			
Subsystem			
Airframe	11	1.7	8.9
Fuselage Compartment	12	0.1	0.6
Landing Gear	13	0.1	0.8
Flight Controls	14	0.5	2.5
Rotor Systems	15	0.3	1.7
Turbo Shaft Powerplant	22	0.8	4.2
Rotary Wing Drive System	26	0.2	1.0
Bleed Air Heat, Ventilation	41	0.0	0.0
Electrical Power Supply	42	0.1	0.5
Lighting System	44	0.0	0.0
Hydraulic Power Supply	45	0.1	0.3
Fuel System	46	0.1	0.6
Misc Utilities	49	0.0	0.2
Instruments	51	0.1	0.3
HF Communication System	61	0.0	0.2
VHF Communications	62	0.5	2.7
UHF Communications	63	0.1	0.4
Interphone	64	0.2	0.8
IFF	65	0.1	0.8
Misc Communications	69	0.0	0.1
Radio Navigation	71	0.2	1.3
Radar Navigation	72	0.0	0.0
Weapon Delivery	75	0.0	0.1
Emergency Equipment	91	0.0	0.0
Miscellaneous Equipment	96	0.0	0.0
Explosive Devices	97	0.0	0.0
Totals for Corrective Maintenance		5.3	27.9
UH-1N Aircraft Totals		18.8	

Table XXXI

CODE DEFINITIONS

Action-Taken Codes	
Code	Definition
F	Repair
G	Repair and/or replacement of minor parts, hardware, and softgoods
K	Calibrated-adjustment required
L	Adjust or reset
P	Removed
R	Remove and replace
S	Remove and reinstall
Z	Corrosion treatment
How-Malfunctioned Codes	
Code	**Definition**
086	Improper handling
092	Mismatched
105	Loose or damaged bolts, nuts, screws, rivets, fasteners, clamps or other common hardware
106	Missing bolts, nuts, screws, rivets, fasteners, clamps or other common hardware
108	Broken, faulty or missing safety wire or key
142	Engine removed, excessive maintenance
204	Accidental explosion of, or damage from onboard munitions
230	Dirty, contaminated or saturated by foreign material
246	Improper or faulty maintenance
301	Foreign object damage
303	Bird strike damage
424	External power source
518	Improper routing
[illegible]3	Does not meet specification, drawing, or other conformance requirements
[illegible]	Failed or damaged due to malfunction of associated equipment or item

Table XXXI (Concluded)

Code	Definition
709	Administrative condemnation
731	Battle damage
793	No defect - TCTO kit received by base supply or parts available in base supply
797	No defect - T.O. previously complied with
798	No defect - T.O. not applicable - equipment to be replaced, modified or not installed
799	No defect
800	No defect - component removed and/or reinstalled to facilitate other maintenance
801	No defect - T.O. compliance
802	No defect - partial T.O. compliance
803	No defect - removed for time change
804	No defect - removed for scheduled maintenance or modification
812	No defect - indicated defect caused by associated equipment malfunction
877	Transportation damage
878	Weather damage
911	Engine TCTO correction (reference T.O. 00-20-4)
931	Accidental or inadvertent operation, release or activation

Table XXXII

INTERNAL NOISE ENVIRONMENT, UH-1N HELICOPTER

Test Data	Location Sampled	Conditions	Octave Band or Response Range (db)*											
			Over-all	Low Pass to 75 Hz	18-37	37-75	75-150	150-300	300-600	600-1,200	1,200-2,400	2,400-4,800	4,800-9,600	9,600 20,000
18 Nov 70	Center forward cargo area	Ground idle 100-pct rotor rpm Cargo doors open	110	103	94	103	97	95	89	88	96	84	85	86
22 Jul 71	Center rear cargo area	Ground idle 100-pct rotor rpm Doors closed	102	102	94	90	94	95	94	98	90	81	82	81
18 Nov 70	Center forward cargo area	Hover taxi	103	101	100	97	94	92	87	86	84	80	83	71
22 Jul 71	Center rear cargo area	Hover taxi	123	123	105	98	96	93	92	99	98	82	81	79
22 Jul 71	Center console, level of pilot's head	90 KIAS 5,000 ft MSL Cruise	126	126	106	103	100	93	87	90	84	81	85	84
18 Nov 70	Center forward cargo area	90 KIAS 11,500 ft MSL Cruise	103	101	96	98	94	91	86	86	84	78	86	79
22 Jul 71	Center cargo area	100 KIAS 4,000 ft MSL Cruise	128	128	112	99	92	91	88	96	90	83	81	75
22 Jul 71	Center cargo area	100 KIAS 5,000 ft MSL Cruise	128	128	112	103	99	94	90	96	89	83	82	76
18 Nov 70	Center cargo area	5,000 ft MSL Cruise	107	107	100	98	97	95	92	87	87	78	79	73
18 Nov 70	Center forward cargo area	80 KIAS 1,000 ft per min descent 7,000-5,000 ft MSL	106	106	92	97	96	91	87	87	86	80	85	79

*Reference 0.0002 dynes/cm^2.

Table XXXIII

EXTERNAL NOISE ENVIRONMENT, UH-1N HELICOPTER

Location Sampled	Conditions	Octave Band or Response Range (db)*											
		Over-all	Low Pass to 75 Hz	18-37	37-75	75-150	150-300	300-600	600-1,200	1,200-2,400	2,400-4,800	4,800-9,600	9,600-20,000
60 ft from rotor mast, 0 deg forward	100 pct rotor rpm	107	107	103	102	99	95	91	91	91	85	89	81
90 deg side		107	104	101	100	96	98	95	94	94	94	82	74
135 deg rear		109	105	100	101	105	95	97	104	97	84	84	73
180 deg rear		104	102	98	101	99	96	84	83	83	85	72	65
25 ft forward of rotor mast	Hover at 5 ft	120	120	111	106	108	105	102	101	105	94	92	95
50 ft from rotor mast, 135 deg rear	Hover at 5 ft	115	113	110	103	100	85	82	87	80	82	86	82

*Reference 0.0002 dynes/cm^2.

Table XXXIV

AIRCRAFT NOISE LEVELS DURING LOUDHAILER OPERATION

Location	Background Noise Level (db)	Signal and Noise Loudhailer Extended (db)	Signal and Noise Loudhailer Retracted (db)
Pilot head level	110	117	118
Copilot head level	112	112	115
Loudhailer operator	109	128	127
Left rear cargo seat	112	124	132
Right rear cargo seat	112	118	116

REFERENCES

1. UH-1N Category II Propulsion System Evaluation, FTC-TR-71-39, Air Force Flight Test Center, Edwards AFB, California (to be published).

2. UH-1N Category II Armament Evaluation, FTC-TR-71-38, Air Force Flight Test Center, Edwards AFB, California (to be published).

3. UH-1N Category II Systems Test Plan, May 1970, Air Force Flight Test Center, Edwards AFB, California.

4. Dowden, Donald J., and Angle, Theodore E., Major USAF, UH-1N Instrument Flight Turbulence and Icing Tests, FTC-TR-71-9, Air Force Flight Test Center, Edwards AFB, California, March 1971.

5. Ford, James A., and Angle, Theodore E., Major USAF, UH-1N Category II Tropical Weather Tests, FTC-TR-71-1, Air Force Flight Test Center, Edwards AFB, California, February 1971.

6. Ford, James A., and Nelson, Gary L., Major USAF, UH-1N Category II Climatic Laboratory Tests, FTC-TR-71-36, Air Force Flight Test Center, Edwards AFB, California, August 1971.

7. UH-1N Category II Desert Tests, FTC-TR-71-48, Air Force Flight Test Center, Edwards AFB, California (to be published).

8. UH-1N Category II Performance Tests, Air Force Flight Test Center, Edwards AFB, California (to be published).

9. UH-1N Category II Flying Qualities, Air Force Flight Test Center, Edwards AFB, California (to be published).

10. Springer, Robert H., et al., Air Force Preliminary Evaluation of the UH-1N Helicopter, FTC-TR-70-22, Air Force Flight Test Center, Edwards AFB, California, August 1970.

11. Flight Manual USAF Model UH-1N Helicopter, T.O. 1H-1(U)N-1, 1 August 1970.

12. USAF Materiel Deficiency Reporting System, T.O. 00-35D-54, 1 May 1970.

13. Technical Manual, Organizational Maintenance USAF Series UH-1N Helicopter, T.O. 1H-1(U)N-2-1, 1 December 1970.

14. Technical Manual, Organizational Maintenance for SA-1800C Loudspeaker System, T.O. 1255-4-31-2, 14 August 1967.

15. Avionics Bench, Preflight and Flight Test Instructions for Radio Set AN/ARC-115, SCL-T-0045B, 26 October 1968.

16. Avionics Bench, Preflight and Flight Test Instructions for Radio Set AN/ARC-116, SCL-T-0046B, 28 October 1968.

17. Avionics Bench, Preflight and Flight Test Instructions for Radio Set AN/ARC-114, SCL-T-0044B, 28 October 1968.

18. Direction Finder Group AN/ARA-50, MIL-D-38402 (USAF), 18 May 1965.

19. Technical Manual, Field Maintenance, Radio Set AN/ARC-65, T.O. 12R5-2ARN-56-2, 5 June 1969.

20. Westman, H.P., et al., Reference Data for Radio Engineers, Fourth Edition, American Book, Stratford Press Incorporated, N.Y., N.Y.

21. Maintenance Manual, Direction Finder Set AN-ARN-89, TM 11-5826-227-34, January 1971.

22. USAF Model UH-1 Helicopter Avionics Test Report (Engineering Approval Test), Report No. 212-099-065, Bell Helicopter Company, Fort Worth, Texas, March 1971.

23. Radio Receiving Set AN/ARN-82, TM 11-5826-226-35, April 1966.

24. Technical Manual, Service Instructions with Illustrated Part Breakdown Electronic Altimeter Set AN/APN-171(V), T.O. 12P5-2APN-171-2, 15 October 1968.

25. Antenna for Aircraft Marker Beacon Equipment, General Specification for Design of, MIL-A-5999A (USAF), 30 April 1958.

26. DOD AIMS Preflight and Test Procedures (Air Force), DOD AIMS Document No. 153, Aeronautical Systems Division, Wright-Patterson AFB, Ohio, 15 February 1971.

27. Detail Specification for Twin Engine Helicopter, BHC 212-947-010, Bell Helicopter Company, Fort Worth, Texas, 14 October 1969.

28. Handbook of Instructions for Aerospace Personnel Subsystem Designs AFSCM 80-3, 15 April 1967 (latest revision).

29. Design Handbook, Personnel Subsystems, AFSC DH1-3, 1 July 1970.

30. Human Engineering Design Criteria for Aerospace Systems and Equipment, MIL-STD-803A-3, date unknown.

31. Human Engineering Design Criteria for Military Systems Equipment and Facilities, MIL-STC-1472A, 15 May 1970.

32. Illustrated Parts Breakdown, UH-1N, T.O. 1H-1(U)N-4, 1 January 1971.

33. Design Handbook, System Safety, AFSC DH 1-6, 20 July 1970.

34. Conventional Munitions Loading Procedures, T.O. 1H-1(U)N-33-1-2, 1 December 1970.

35. Maintenance Technical Directive 69-1, Air Force Systems Command System Effectiveness Data System AFSC Form 258/258-4 Maintenance Data Recording Procedures, 1 September 1970.

36. Work Unit Code Manual, T.O. 1H-1(U)N-06, 1 October 1970.

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)
Air Force Flight Test Center
Edwards Air Force Base, California

2a. REPORT SECURITY CLASSIFICATION
UNCLASSIFIED

2b. GROUP
N/A

3. REPORT TITLE
(6) UH-1N Category II Airframe and Subsystems Evaluation.

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
(9) Final rept.,

5. AUTHOR(S) (First name, middle initial, last name)
(10) Hugh M. Helmick ~~Captain~~, USAF
Edward B. Russell ~~Major~~, USAF

(11) Nov 71 (12) 112p.

6. REPORT DATE
~~November 1971~~

7a. TOTAL NO. OF PAGES
131

7b. NO. OF REFS
36

8a. CONTRACT OR GRANT NO.

b. PROJECT NO.
(16) AFFTC-~~Project Directive~~ 66-49

c.

d.

9a. ORIGINATOR'S REPORT NUMBER(S)
(14) AFFTC-TR-71-37

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
N/A

10. DISTRIBUTION STATEMENT Distribution limited to U.S. Government agencies only (test and evaluation), [redacted]. Other requests for this document must be referred to ASD (SDQH), Wright-Patterson AFB, Ohio 45433.

11. SUPPLEMENTARY NOTES
N/A

12. SPONSORING MILITARY ACTIVITY
6510 Test Wing
Edwards AFB, California

13. ABSTRACT

UH-1N subsystems tests were flown with three Category II test helicopters. The aircraft was found capable of performing its mission adequately. The airframe, fuselage compartment, flight controls and electric utility system were found to be generally acceptable. Mechanical tail rotor pitch control problems and crew reach difficulties with seat armor installed were notable exceptions. The rescue hoist and cargo suspension unit operated satisfactorily. The loudspeaker system kit proved largely ineffective even after correction of circuitry problems. Early VHF-AM and UHF communications shortcomings were effectively corrected by a TCTO. The AN/ARC-102 receiver-transmitter became inoperative and did not become operational in time for completion of tests. Most other avionics equipment, including navigation aids, proved satisfactory although specifications for such equipment often were not met. Reliability and maintainability figures for onboard systems were determined. The powerplant, transmission, electrical power, flight instruments, VHF-AM transceiver, tacan and UHF-DG systems were identified as reliability problem areas. Engine access was difficult and time consuming and changes to engine cowling and baffle fasteners were recommended.

mk (012 100)

DD FORM 1473 NOV 65

UNCLASSIFIED
Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
UH-1N helicopter						
airframe and subsystems evaluation						